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INDIVIDUAL AND SEASONAL VARIATIONS IN HELOPELTIS THEIVORA, WATER-HOUSE, WITH DESCRIPTION OF A NEW SPECIES OF HELOPELTIS

BY

HAROLD H. MANN, D.SC

Scientific Officer, Indian Tea Association

AGRICULTURAL RESEARCH INSTITUTE, PUSA

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I.—INTRODUCTORY.

The genus *Helopeltis* of the Capsidæ was formed by Signoret in 1858 to receive an insect found by Antoine Dohrn in Ceylon. It has since been brought into more prominence than almost any other among this family of heteropterous bugs, because the members of it have proved to be among the most serious pests of several cultivated tropical crops, among which are tea, cinchona, and cocoa. Their occurrence as serious pests of tea has led to the possibility of my examining many thousands of specimens of the common Indian form (*Helopeltis theivora*, Waterhouse), derived from a number of different districts, and collected at all seasons of the year. It is rare, indeed, that such an opportunity occurs for examining the morphological variations in an insect, and I trust that the details of my observations may not be entirely valueless.

It is well known that if normal examples of almost any insect are to be obtained, they must be collected and not bred. So soon as insects are brought into captivity and allowed to breed there, they are liable to extraordinary variations. This has been commonly observed in the case of the moths, but is not confined

to the order of Lepidoptera. In spite of the knowledge of this fact, very slight variations in the coloration or relative size or even of total size of insects has been considered sufficient to create a new species with a new name. In most cases this may be justifiable, but before there can be certainty whether this is so or not, it is necessary to examine a very large number of insects of the species in question existing under natural conditions, and to ascertain how far variation even under such conditions may occur within the one species. This has, in most cases, not been done from lack of material, for many species have been named from single type specimens, but even where possible has rarely indeed been carried out. The result has been that the same species has, in many cases, been named over and over again, and that entomology is cumbered with a multitude of names which represent mere individual or seasonal variations of a single insect.

II.—HISTORICAL.

The original description of the genus *Helopeltis* runs as follows :—

"Genre 'Helopeltis,' Signoret.

De même forme que le genre précédent (*Pachypeltis*), il s'en distingue facilement par l' aspect de l'ecusson qui présente sur son disque une épine. Antennes avec le premier article aussi long que la tête et le prothorax : second article le plus long : troisième et quatrième courts. Abdomen débordant les élytres."

The most recent description of the same genus (*Distant, Fauna of British India. Rhyncota, Vol. II, p.* 439), is as follows :—

"Body elongate ; head broad, deflected in the front of eyes, discally and centrally longitudinally incised or sulcated: antennæ inserted in front of, but on a level with the inner margin of the eyes, with the first joint about as long as the head and pronotum together ; its apex moderately incrassated ; pronotum strongly constricted before the middle, posterior margin more than twice the width of anterior ; scutellum with a long more or less erect horn or spine, its apex clavate ; legs moderately long and slender, femora nodulose."

In one point the description of the genus by Signoret must be corrected. This refers to the length of the joints of the antenna. Usually the second and third joints are of nearly equal length in *Helopeltis theivora*, in the males the third being usually slightly longer than the second, while in the females the opposite is the case.

The specific characters of *Helopeltis theivora* were thus described by Waterhouse in 1886 :—

" Female—Black, thorax orange yellow, with a black line near the front margin, the base margined with black. Scutellum brown, black at the base, the horn long, much curved, black, brown at the apex. Antennæ dark brown, the basal joint paler, yellow at the base. Femora dark brown, mottled with light brown, with a light yellow ring at the base. Tibiæ light brown, speckled with dark brown. This species is at once distinguished from the two preceding species (*Helopeltis Antonii* and *Helopeltis Bradyi*) by the longer and curved horn on the scutellum."

He adds that Peal states when full grown " the colour deepens " and " it turns black on the head and thorax." Waterhouse remarks also that it has the scutellar horn longer and stouter than *Helopeltis antonii*, and that it may easily be distinguished by this means.

The next writer on the subject (Atkinson, *Indian Museum Notes, Vol. I, p.* 175 (1890)), simply repeats Waterhouse's description without making any addition.

Dudgeon (*Indian Museum Notes, Vol. III, No.* 5, *pp.* 34-35 (1896)), added considerably to this description, by giving an account of the oviposition and of the ovipositor. Of the latter he says : " The ovipositor . . . . . is more than half as long as the rostrum. It is difficult to distinguish it on the underside of the abdomen, folded, as it is, close against the dark shiny surface which it matches well in colour ; but if the body be pressed, it rises from the surface and can be distinctly seen with the naked eye. It is in the form of a curved, corneous process rising from the centre of the sixth abdominal segment on the underside, and reaching to the eighth segment. Its colour, like that of the posterior abdominal segments, is dark brown.

" It will be seen by referring to Mr. Waterhouse's description of the insect that no mention is made of the colour or markings of the abdomen, although the latter are well shown in the plate given with it. I, therefore, conclude that the description was made from dried specimens from which the colour had gone, as

soft-bodied insects do not preserve it long. The abdomen in fresh specimens of both sexes is invariably bright emerald green by transparency, marked dorsally on the third to ninth segment with shiny dark brown. The extent of brown on the third segment is limited to a small dorsal patch, or is altogether absent : on the fourth it extends over the whole dorsal region : on the fifth, partially lateral and wholly dorsal, the remaining segments are all dark brown ; the segmental divisions are greenish. The male differs from the female in having the pronotum very slightly tinged with yellow : the abdomen more slender and the absence of the ovipositor. "

Except for a short publication by the present author in 1903 (*Indian Museum Notes, Vol. VI, No.* 1), the only further formal description on record is that by Distant (*Fauna of British India, Rhyncota, Vol. II, page* 440). His account is as follows :—

" Male—Head and pronotum shining black, much resembling the same sex of the preceding species (*H. antonii*), but with the scutellar horn more curved backward at apex.

" Female—Black, pronotum bright shining stramineous or ochraceous, with a subapical transverse fascia and the basal area shining black ; scutellum ochraceous, more or less suffused with black, the horn long, black, piceous at apex ; antennæ dark brown, basal joint paler, yellowish at base ; femora dark brown, mottled with ochraceous, and with a distinct pale annulation near base ; tibiæ ochraceous speckled with fuscous ; head beneath with a lateral luteous fascia on each side, more obscurely seen above : abdomen pale creamy ochraceous, the apical third black. "

Distant attaches great importance in specific classification to the amount of bending of the scutellar horn. This, he says, is nearly straight and perpendicular in *Helopeltis antonii*, and more or less distinctly curved backwards in *Helopeltis theivora*.

It will be seen that these various descriptions do not by any means agree in every point. In fact, from them it would appear almost impossible to discriminate between the several species. Thus in an early stage of the present investigation I found the bending of the scutellar horn, on which Distant lays stress, one

of the most variable features of the insect. Many examples were found, more especially among the males of *Helopeltis theivora*, whose scutellar horn was hardly, if at all, bent, while others, especially among the females, had it bent very markedly. The colour variations were almost numberless; the tints of the pronotum ranged from a very dark ochraceous almost red, to a very slight straw colour. The amount of colour also varied markedly. I have had insects, especially females, in which there was not a mark of black (except the eyes), throughout the whole insect, while others have had almost as little ochraceous or green as a male.

III.—GENERAL METHOD OF STUDY.

The method by which I have studied the variations is as follows. By the kindness of some of the planters of the Indian tea districts, I have been supplied with the whole of the adult insects caught in various months of the year on their property, feeding on the tea bushes. In one case,—Behalli, Durrung, Assam,—I have had them sent to me for *every* month in the year, preserved in weak spirit. Experience has shown that this method of preservation has little effect, except to dull it slightly, even on the colour, and that the insects can be so kept for examination for a very long time. The males and females, which are easily distinguishable (*vide* my paper on the relative proportion of the sexes

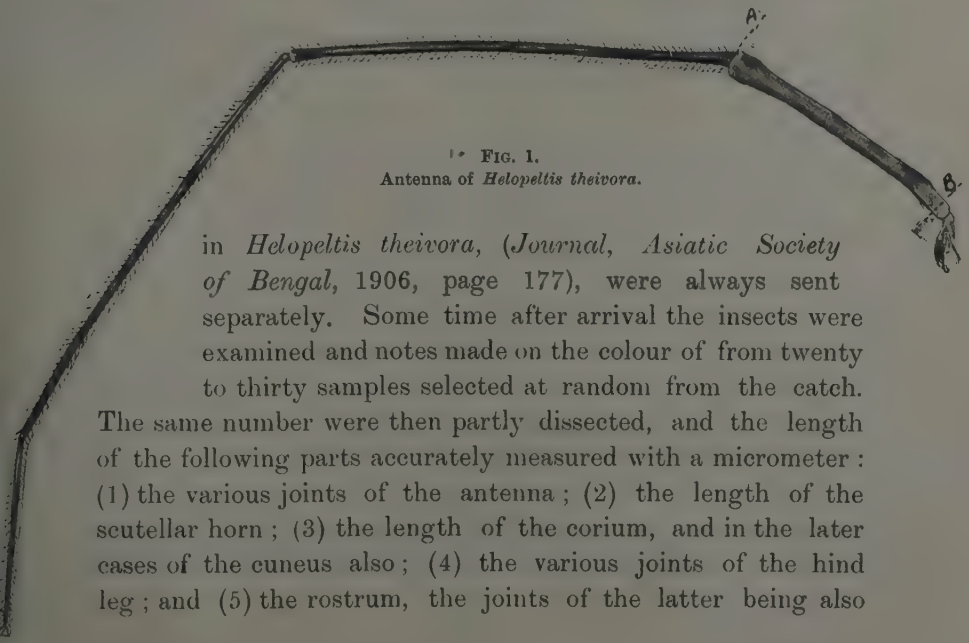

Fig. 1.
Antenna of *Helopeltis theivora*.

in *Helopeltis theivora*, (*Journal, Asiatic Society of Bengal*, 1906, page 177), were always sent separately. Some time after arrival the insects were examined and notes made on the colour of from twenty to thirty samples selected at random from the catch. The same number were then partly dissected, and the length of the following parts accurately measured with a micrometer: (1) the various joints of the antenna; (2) the length of the scutellar horn; (3) the length of the corium, and in the later cases of the cuneus also; (4) the various joints of the hind leg; and (5) the rostrum, the joints of the latter being also

measured in a few cases. In the case of one fairly typical individual in most of the sets of insects, there were measured in addition, (1) the intermediate leg; (2) the foreleg; (3) the maximum length of the hemelytra; (4) the length of the head and pronotum together. In order to make absolutely clear what the figures mean, it will be necessary to state exactly the lengths that were measured.

Antenna.—In measuring the first joint of the antenna, a difficulty arose as to what to take as the point of origin, which was difficult to define in a dissected organ. I ultimately found that by far the most definite results could be obtained by commencing the measurements from a slight constriction in the antenna, which occurs just after the organ leaves the head, as shown at B in the figure attached. The other joints presented no difficulty.

Fig. 2.
Scutellar Horn of *Helopeltis theivora*.

2. *Scutellar Horn.*—The difficulty of defining the point of origin of the scutellar horn was so great that I ultimately gave up measuring it; and figures have only been recorded for the earlier months. When measured, the measurement was made from *a* to *b* in Figure 2.

3. *Corium* and *Cuneus.*—It was possible to make these measurements very accurately, the particular points taken being shown in Fig. 3. *a* to *b* representing the length of the corium, and *b* to *c* the cuneus.

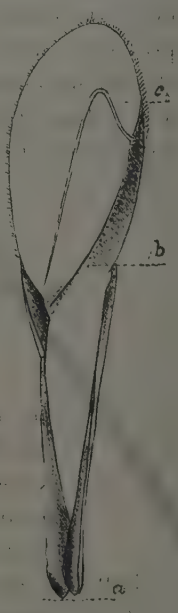

Fig. 3.
Hemelytron of *Helopeltis theivora*.

4. *Legs.*—The measurement of the legs presented some difficulty. It was ultimately decided to take the length of the femur with the trochanter, making allowance for the curvature. This allowance

amounted normally to the addition of ·06 millimeters to the length actually measured. The root end of the tibia was difficult to define, as it was always bent over at the point of junction with the femur. Fig. 4 shows the points ultimately adopted for the purpose, and it was usually, but not always, marked by the presence of a longish hair.

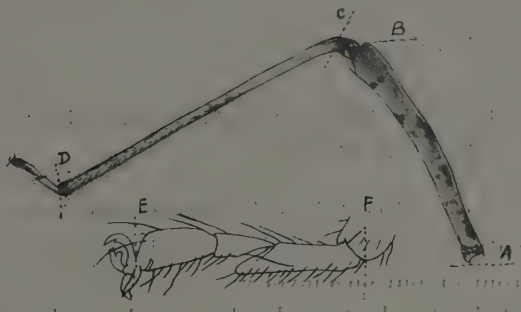

FIG. 4.
Hind leg of *Helopeltis theivora*.

5. *Rostrum.*—The whole of the four joints were measured, the point of origin being usually easy to locate. See Fig. 5.

FIG. 5.
Rostrum of *Helopeltis theivora*.

The measurement of the remaining parts presents no difficulty.

A number of tests were made in order to ascertain how nearly the measurements were accurate. It was found that they could always be relied on to ·06 millimeter, though most were within ·03 millimeter.

The variations in the insect can perhaps best be described by indicating what are the typical characters of the principal parts of the insect, and then describing the amount of variation which I have noticed in individuals.

IV.—INDIVIDUAL AND SEASONAL VARIATION OF THE MALE.

Head.—Typically the head is "Broad, deflected in front of eyes, discally and centrally longitudinally incised or sulcated. Antennæ inserted in front of but on a level with the inner margins of the eyes." (Distant, *l c.*). Just inside the insertion of each of the antennæ, there is a minute but very marked tubercle, black, about ·06 mm. long. The whole is black both above and below.

Variations.—The variations principally affect the colour, which may be anything from bright shining black to a mere suffusion of black over ochraceous. The eyes are always black. A small ochraceous lateral fascia is very common.

Antennæ.—The antennæ consist of four joints, the second, third and fourth being a shining brownish black, while the first is dark brown with a basal yellowish ring. This first joint is moderately thickened at the apex. The average length of the several joints comes out as follows :—

	January to April.	May to December.	
	mm.	mm.	
First joint	2·31	2·50	
Second joint	4·31	4·56	
Third joint	4·42	4·70	
Fourth joint	1·63	...	

The fourth joint is very easily broken off, and it is rarely that it is present in caught samples. The whole antenna is, however, very much tougher than in the female, where even the third joint is very often broken off in catching the insects. The whole of the second, third and fourth joints are hairy, the hairs reaching a length on the second joint of ·08 mm.

Variations.—The colour variations of the antennæ are very slight.

The differences in the size of the various joints are, however, very great, and this applies to individuals occurring in the same month, and in a much greater measure to individuals in different times of the year. It will be well in this matter to take each joint of the antenna separately, and show the extreme variations, the prevailing size, and the general average for each month.

(*a*) *First joint of Antenna.*

Month.	Longest specimen.	Shortest specimen.	Prevailing size.	General average.
	mm.	mm.	mm.	mm.
January	2·67	1·90	2·30—2·33 and 2·50—2·53	2·29
February	2·37	1·83	1·90—1·93 and 2·10—2·20	2·08
March	2·53	2·13	2·27—2·37	2·31
April	2·70	2·37	2·53—2·66	2·58
May	2·77	2·47	2·53—2·63	2·57
June	2·83	2·30	2·43—2·53	2·49
July	2·67	2·30	2·43—2·60	2·48
August	2·70	2·30	2·50—2·60	2·52
September	2·70	2·37	2·47—2·53 and 2·63	2·53
October	2·80	2·20	2·47—2·60	2·51
November	2·67	2·13	2·37 and 2·43—2·53	2·44
December	2·67	2·17	2·30—2·40 and 2·47—2·50	2·41

(*b*) *Second joint of Antenna.*

Month.	Longest specimen.	Shortest specimen.	Prevailing size.	General average.
	mm.	mm.	mm.	mm.
January	5·03	3·60	4·20—4·27 and 4·53—4·63	4·34
February	4·23	3·57	3·93—4·17	3·94
March	4·63	3·97	4·17—4·37	4·28
April	5·00	4·44	4·60—4·67 and 4·73—4·77	4·69
May	5·57	4·20	4·47—4·53 and 4·60—4·67	4·66
June	5·00	4·23	very variable from 4·17—4·87	4·56
July	5·43	3·83	4·40—4·57	4·46
August	5·63	3·93	4·63—4·70	4·59
September	5·03	4·23	4·50—4·63	4·60
October	4·97	4·10	4·53—4·60 and 4·73—4·80	4·59
November	5·10	3·87	no prevailing size, most at 4·57	4·52
December	4·87	3·90	4·33—4·37 and 4·50—4·60	4·50

(c) *Third joint of Antenna.*

Month.	Longest specimen.	Shortest specimen.	Prevailing size.	General average.
	mm.	mm.	mm.	mm.
January ...	4·87	3·73	4·47—4·67	4·36
February	4·43	3·77	3·97—4·20	4·03
March	4·77	4·27	4·37—4·47	4·46
April	5·00	4·66	4·66	4·83
May	4·90	4·40	4·60—4·70	4·66
June	5·23	4·37	4·50—4·70	4·69
July	4·93	4·03	4·77—4·90	4·66
August	5·03	4·40	4·77—5·00	4·76
September	5·03	4·47	4·77—4·90	4·76
October	5·13	4·53	4·53—4·77	4·77
November	5·10	4·07	4·47—4·60	4·66
December	4·80	4·33	4·53—4·63	4·60

(d) *Fourth joint of the Antenna.*—Sufficient of these were not obtained to allow the figures being set out in detail. Those measured varied from 1·70 mm. to 1·58 mm.

From a consideration of these figures it seems that the following conclusions can be drawn.

1. That there is a large variation in the measurements of the antennæ of individual insects collected in the same month. This amounts to an increase in the length of each of the three measured joints as follows. The percentages given show the percentage by which the longest is longer than the mean, and the shortest shorter than the mean.

	First Joint.		Second Joint.		Third Joint.	
	Extreme variation above mean.	Extreme variation below mean.	Extreme variation above mean.	Extreme variation below mean.	Extreme variation above mean.	Extreme variation below mean.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
January ...	16·5	17·0	15·9	17·0	11·7	14·5
February ...	14·0	12·0	7·4	9·4	10·0	6·5
March ...	9·6	7·8	8·1	7·2	7·0	4·2
April ...	4·6	8·1	6·6	5·3	3·5	3·5
May ...	7·8	3·9	19·5	10·0	5·1	5·5

	First Joint.		Second Joint.		Third Joint.	
	Extreme variation above mean.	Extreme variation below mean.	Extreme variation above mean.	Extreme variation below mean.	Extreme variation above mean.	Extreme variation below mean.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
June ...	13·6	7·6	9·7	7·2	11·5	6·8
July ...	7·6	7·3	21·7	14·1	5·8	13·4
August ...	7·2	8·8	22·6	14·3	5·6	7·5
September ...	6·7	6·3	9·4	8·0	5·6	6·0
October ...	11·6	12·4	8·3	10·6	7·5	5·0
November ...	9·4	12·7	12·9	14·4	9·4	12·5
December ...	10·8	10·0	8·2	13·3	4·3	5·9

Thus in the same month individuals may differ from the mean by over twenty per cent. in the length of one of the joints of the antennæ, and still be within the single species *Helopeltis theivora*.

2. That there is a regular variation with the seasons. The shortest antennæ among the males are found in February in Upper Assam. From this time the length rapidly increases till April, and then remains almost constant until November or December. The maximum, minimum and mean length for each joint for the whole season is approximately as follows :—

	Maximum.	Minimum.	Mean.
	mm.	mm.	mm.
First joint ...	2·83	1·83	2·43
Second joint ...	5·57	3·57	4·48
Third joint ...	5·23	3·73	4·60

3. That combining individual and seasonal variations of the antennæ, we find that—

(*a*) the first joint varies from 12·3 per cent. above the mean to 24·7 per cent. below it;

(*b*) the second joint varies from 24·3 per cent above the mean to 20·3 per cent. below it;

(*c*) the third joint varies from 13·7 per cent. above the mean to 18·9 per cent. below it.

Rostrum.—Last among the parts attached to the head to be described is the rostrum, consisting of four joints and coloured obscure ochraceous, the tip being dark brown—nearly black on

occasions. It is sparsely scattered with hairs, and the tip is very hairy. The average length of the rostrum and of its joints is as follows:—

Length of Rostrum	... ...	1·73 millimetres.
„ „ base joint (by difference)	... ...	·39 „
„ „ second joint from base	... ...	·38 „
„ „ third joint from base	... ...	·38 „
„ „ tip joint	... ...	·58 „

In life the rostrum is held, at rest, parallel to the body, and reaches exactly to the intermediate coxæ.

Variations.—The rostrum forms one of the most constant parts of the body, both in colouring and in size. Beyond slight variations in the amount of the dark brown colour characteristic of the tip, it may be said to hardly ever differ in colour from the typical form just described. The size is also remarkably uniform. Differences, both individual and seasonal, do occur, and, so far as the length of the whole rostrum is concerned, are shown in the following table:—

Month.	Longest specimen.	Shortest specimen.	Prevailing length.	General Average.
	mm.	mm.	mm.	mm.
January	1·83	1·57	1·67—1·70	1·69
February	1·90	1·53	1·63—1·73	1·67
March	1·80	1·63	1·70—1·73	1·72
April	1·87	1·63	1·70—1·77	1·74
May	1·83	1·60	1·70—1·77	1·74
June	1·87	1·63	1·70—1·77	1·74
July	1·87	1·60	1·70—1·77	1·73
August	1·90	1·63	1·73—1·77	1·76
September	1·87	1·67	1·73—1·80	1·76
October	1·83	1·67	1·77—1·80	1·76
November	1·93	1·67	1·73—1·80	1·75
December	1·83	1·63	1·73	1·73

Seeing that the possible error of each observation is about ·06 mm., the certain conclusions to be drawn from these figures are—

(1) that the only seasonal variation is a reduction in average size in the cold weather of about 3·5 per cent., the minimum being reached in February;

(2) that the individual variation is much greater than the seasonal variation, but the number of exceptional individuals is

small, the very large majority in any one month lying between the limits of experimental error.

The length of individual joints of the rostrum was only determined for a few months, and then only by examination of five individuals in each month. The figures obtained were, however, as follows :—

Month.	2nd Joint.	3rd Joint.	Tip Joint.
	mm.	mm.	mm.
February	·37	·35	·56
March	·38	·39	·59
August	·39	·39	·59
September	·41	·40	·59
October	·35	·38	·58
December	·39	·39	·59

No further conclusion as to the variation of these items can be drawn, but, on the whole, they confirm those indicated above for the whole rostrum.

Pronotum.—The typical pronotum in the male of *Helopeltis theivora* has never been formally described. It conforms to the general characters of this part of the body in the genus by being "strongly constricted before the middle," while the posterior margin is "more than twice the length of the anterior" (Distant). It sometimes agrees in colouring with the characters given for *Helopeltis antonii* ("anterior margin narrowly obscurely ochraceous" (Distant), but the colouring is exceedingly variable. My remarks on the variations of the pronotum will be entirely concerned with the changes in colouring. These changes have only been observed for four of the months in the year. I shall call the part of the pronotum anterior to the constriction the 'collar.'

The colouring of the collar was only observed for a series of samples in March, August, September, and December.

(*a*) In March, of twenty-five samples examined, ten had the whole of the collar black, nine wholly ochraceous, one ochraceous with a black spot in the middle, and five had an undefinable mixture of black and ochraceous.

(*b*) In August, there were nine samples with the collar black, fourteen with it ochraceous, and two with an undefinable mixture.

(*c*) In September, there were fourteen with a black and nine with an ochraceous collar, while the remaining one had a black spot in the middle of an ochraceous collar.

(*d*) In December, the collar was black in eleven cases and completely ochraceous in none. In nine cases the anterior portion was ochraceous, while the posterior was black, while the colour was undefinable in the remainder.

In general one may say that the colour of the collar of the pronotum is extremely variable. Perhaps there is a greater tendency to ochraceous in the height of the season, and to black during the colder and less active time of the year.

The remainder of the pronotum is equally variable in its colour markings. Typically it may be said to be black with a large ochraceous spot on each side slightly anterior to the middle, but the range of variations includes a completely black pronotum, and one where the whole anterior portion is ochraceous. Taking the same months as given above, the following variations have been observed :—

(*a*) In March, out of 25 samples, eleven were of the kind described above as typical, though the size of the ochraceous spots was very variable. In fourteen cases, the ochraceous spots join in the middle, forming a band varying in width in the centre from one-eighth to one-half the width of this portion of the pronotum.

(*b*) In August, ten samples were typical, four had an ochraceous band of variable width right across ; and eleven had the portion of the pronotum now under discussion, entirely black.

(*c*) In September, only five samples (out of twenty-four) were typical, three had the ochraceous band right across the pronotum, and sixteen were entirely black.

(*d*) In December, on the other hand, sixteen insects (out of twenty-five) were typical, but with ochraceous spots very variable

in size, sometimes nearly meeting in the centre: eight had the ochraceous band right across; and only one was entirely black.

These notes seem to indicate a tendency to be blacker in the height of the season, a conclusion which is the reverse of that which appears to obtain for the anterior part ("collar") of the pronotum.

Head and Pronotum.—Before passing on to consider the scutellum, I may note an error which seems to recur in nearly all the descriptions of the insect, that "the first joint of the antennæ is about as long as the head and pronotum together" (Distant). In reality it is much longer. I have already stated that the first joint of the antenna is, as a mean for the whole year, 2·43 millimetres long. The combined length of the head and pronotum (excluding the scutellum) is, in various months, as follows:—

Month.	Combined length of head and pronotum.
	mm.
January	1·47
February	1·33
March	1·53
August	1·53
September	1·57
October	1·62
December	1·63

It should be noted, however, that these measurements were of single individuals during these months, and are not average values.

Scutellum.—I have not been able to investigate the colour variations of the scutellum itself. Typically it is, as Distant describes (l. c.), for *Helopeltis antonii* "black, testaceous at apex." The scutellar horn is, however, a point of great interest. The drumstick-shaped horn is characteristic of the genus, and has been used as a mark of specific differences. Waterhouse distinguished *Helopeltis theivora* from *Helopeltis antonii* by the fact that the former has "the scutellar horn longer and stouter," and also by the fact that in the former case it is said to be bent. Distant makes the amount of bending in the horn a primary division of the genus. Hence one would expect that both in size

and shape it would be of the most constant character. As a matter of fact, it is extremely variable, in size, colouring and shape. In size the specimens for different months vary, on the averages, by at least fifteen per cent. in length; in colouring it varies from being almost entirely ochraceous with two small black patches to being entirely black; in shape it varies from being bent backwards very strongly to possessing hardly a perceptible curve. I will deal with these variations in succession.

Though as I have said before (page 5) the scutellar horn is difficult to measure owing to the indefinite character of its lower termination, yet results which are probably of fair accuracy have been obtained for a number of months. These are as follows:—

Month.	Length of Scutellar Horn.		
	Longest.	Shortest.	Mean.
	mm.	mm.	mm.
January	1·43	1·03	1·23
April	1·25	1·03	1·19
May	1·43	1·17	1·32
June	1·47	1·20	1·35
July	1·47	1·13	1·33
October	1·53	1·13	1·37
November	1·40	1·13	1·30

The difference in the mean due to season works out at fifteen per cent., calculated on the figure for April. The variations from the mean of individuals in each month is a little greater, as follows:—

Month.	Variation of Scutellar Horn from Mean.	
	Variation of Longest.	Variation of Shortest.
	Per cent.	Per cent.
January	16·3	16·3
April	5·0	13·5
May	8·3	11·4
June	9·0	11·1
July	10·5	15·0
October	11·7	17·9
November	7·7	13·1

The colour variations are quite as marked. In what one may perhaps consider the typical form, the scutellar horn is black

with a broad brownish or brownish-ochraceous ring round the middle, and with the tip ochraceous or luteous. The variations from this in a few selected months in the year are as follows :—

(*a*) In March, out of twenty-two horns examined, eighteen were typical as just described, the remaining four being entirely black, except for a tip varying in colour from ochraceous to luteous.

(*b*) In August, out of twenty-four horns examined, twenty-one were typical ; of the remaining three, two were entirely black with the tip luteous, and the other one had the whole of the upper part of the horn ochraceous, with a lighter shaded tip.

(*c*) In September, out of twenty-three specimens, nineteen were typical, two were entirely black, except the ochraceous tip, and two were black throughout (the ochraceous ring being almost or entirely obsolete), including the tip.

(*d*) In December, twenty-two horns were examined. Of these, sixteen were typical, four were black with the tip ochraceous, and two were black or nearly black throughout, including the tip.

The amount of bending of the horn was difficult to describe. That of the males was almost always less than that of the females (*vide infra*), and I have classed them as 'hardly bent,' 'slightly bent,' and 'distinctly bent.' No stronger bending than this was found in any case.

Month.	Scutellar Horn.		
	Hardly bent.	Slightly bent.	Distinctly bent.
	Per cent.	Per cent.	Per cent.
March	17	78	5
August	8	60	32
September	4	58	38
December	36	64	...

These last figures are, of course, liable to a personal error of observation, being classed at different times, but in general, I think, they are sufficiently near to indicate that there is an enormous variety in the amount of bending in the scutellar horn, and that on the whole it is more bent in the height of the season than at other periods.

Such results as I have here recorded seem to dispose very largely of any claim which might be possessed by the scutellar horn to be a basis of classification of the species of *Helopeltis* in any way.

At this point, it may be well to correct the statement in nearly all authorities that the tip of the scutellar horn is cupshaped. This it certainly is usually in dried specimens, but in fresh insects it is clavate and covered with short hairs, among both males and females.

Wings.—The typical hemelytron is long and rather drumstick-like in shape. The clavus is well developed but triangular in shape, being widest at the root of the wing. The corium is not hard, being little thicker than the remaining part of the wing; it passes into the cuneus without any division. The cuneus is brownish in colour, the remainder of the wing, except the veins, being pale transparent. The membrane has only one irregularly shaped vein. The wing membrane is covered with microscopic hairs, and the edge is very distinctly hairy.

The typical hindwing calls for no special remark. It is transparent throughout, with two spur-like veins in the membrane, and is about 1 millimetre shorter than the hemelytron. I have not studied its variations.

The hemelytron is one of the most constant parts of the male *Helopeltis* insect, and it shares to only a very small extent in the reduction in size in the early part of the year. I have measured the length of the corium in a series of samples in each month, the length of the cuneus in two months, and the maximum length of the hemelytron in typical individuals in most of the months.

The maximum length of the wing and that of the corium in the same individuals gave measurements as follows:—

Month.	Maximum length of forewing.	Length of corium.
	mm.	mm.
January	4·70	2·73
February	4·60	2·77
March	4·60	2·77
August	4·63	2·90
September	4·60	2·87
October	4·73	2·83
December	4·87	2·90

The length of the corium in the several months came out as follows :—

Month.	Longest specimen.	Shortest specimen.	General average.
	mm.	mm.	mm.
January	3·13	2·51	2·78
February	2·93	2·50	2·71
March	3·00	2·70	2·82
April ...	3·06	2·74	2·88
May	2·90	2·67	2·80
June	2·90	2·67	2·79
July	2·90	2·53	2·74
August	2·90	2·63	2·76
September	2·93	2·67	2·78
October	2·90	2·60	2·79
November	3·00	2·67	2·83
December	3·00	2·60	2·79

It will be noticed that these figures are remarkably constant. The monthly means do not vary more than 4½ per cent. Individuals in each month vary considerably more than this, showing that we have to do more with an individual than with a seasonal variation. The differences between the largest and smallest wings in January and February are, however, wider than is the case in any other month, indicating that the colder weather or the conditions of life then has a tendency to destroy uniformity. The differences from the mean are shown in the following table :—

Month.	Differences from mean.	
	Longest specimen.	Shortest specimen.
	%	%
January	12·5	9·6
February	8·1	7·8
March	6·4	4·3
April	6·2	4·8
May	3·6	4·6
June	4·0	4·3
July	5·9	7·6
August	5·1	4·7
September	5·4	3·9
October	3·8	6·8
November	6·1	5·7
December	7·5	6·8

The relative length of the corium and cuneus has been determined also for all samples for one month (December). The figures gave (mean) 2·79 mm. for the corium and 1·14 mm. for the cuneus, or a relationship of just under 2½ to 1.

Legs.—The legs of the male of *Helopeltis theivora* have never been described in detail. Distant remarks that they much resemble "those of the preceding species" (*Helopeltis antonii*). The latter are stated to be "brown, speckled with ochraceous, the bases of the femora distinctly ochraceous." The general characteristics of the legs of this genus are, moreover, indicated as follows :—"Legs moderately long and slender, femora nodulose."

The three legs are, in fact, extremely similar in form and colouring, the fore and intermediate legs approximately the same size, and smaller in every respect than the hind leg. Their colouring is as described by Distant, and merely varies slightly in the amount of dark and light colouring found in different samples. The femora are distinctly nodulose, slightly incrassated at the apex, and the trochanter (which I have measured with the femora) is about ·19 mm. long on the inner side in the hind leg. The tibia is straight and very hairy at the lower part. The tarsus is composed of three joints; of these the first is very large and hairy and overlaps considerably the second joint. This last is small, not being half the size of the first joint. The third is intermediate in length, and, like the other two, very hairy. The last joint bears two claws on each side of the tarsus.

My systematic measurements have principally dealt with the hind leg, but in a large number of cases, I have measured the fore, intermediate and hind legs of the same individual. The results thus obtained are as follows :—

Month.	Fore leg.			Intermediate leg.			Hind leg.		
	Femur.	Tibia.	Tarsus.	Femur.	Tibia.	Tarsus.	Femur.	Tibia.	Tarsus.
	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.
January	1·87	2·50	·50	1·87	2·43	·47	2·40	3·00	·50
February	1·83	2·43	·43	1·83	2·33	·43	2·27	2·90	·47
March	2·00	2·53	·50	1·97	2·47	·50	2·43	3·00	·53
August	2·17	2·73	·53	2·13	2·67	·53	2·60	3·30	·50
September	2·17	2·70	·50	2·13	2·70	·50	2·60	3·30	·57
October	2·03	2·67	·50	2·05	2·53	·50	2·50	3·13	·53
December	2·07	2·60	·50	2·07	2·53	·53	2·50	3·07	·50

It will be seen that all the legs share the seasonal reduction in the size undergone by the other appendages to the insect, which occurs in January and February. This is illustrated more completely by the larger series of observations, embracing many samples from every month of the year, on the hind leg. The results are shown in the following table :—

Month.	Length of Femora.			Length of Tibiæ.			Length of Tarsus.		
	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.
	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.
January	2·63	2·20	2·38	3·37	2·80	3·01	·57	·43	·51
February	2·33	1·93	2·20	3·00	2·53	2·80	·50	·43	·48
March	2·50	2·23	2·38	3·20	2·77	2·99	·53	·47	·51
April	2·66	2·40	2·51	3·33	3·00	3·18	·63	·50	·53
May	2·70	2·47	2·59	3·33	3·03	3·17	·57	·50	·51
June	2·83	2·40	2·57	3·40	2·97	3·20	·57	·47	·53
July	2·70	2·30	2·49	3·37	2·87	3·13	·57	·47	·52
August	2·70	2·30	2·54	3·37	2·90	3·20	·57	·47	·53
September	2·73	2·40	2·55	3·37	3·03	3·21	·57	·50	·54
October	2·67	2·23	2·51	3·33	2·80	3·14	·57	·47	·52
November	2·63	2·27	2·51	3·37	2·83	3·13	·53	·47	·52
December	2·67	2·23	2·41	3·33	2·90	3·09	·57	·47	·51

From these figures it will be seen that the individuals vary to a very great extent. The limits are—

(1) for the femora—2·83 mm. to 1·93 mm. or nearly nineteen per cent. above or below the mean ;

(2) for the tibiæ—3·40 mm. to 2·53 mm. or nearly fifteen per cent. above or below the mean ;

(3) for the tarsi—·63 mm. to ·43 mm. or nearly nineteen per cent. above or below the mean.

The seasonal variation of the mean is almost as great. From sizes of 2·20 mm., 2·80 mm., and ·48 mm. for the femur, tibia and tarsus respectively in February, a rise occurs to 2·55 mm., 3·21 mm., and ·54 mm. in September. It is, however, interesting to note that the hind leg has given markedly constant figures from April to November, and that a noticeable decrease in size occurs in December, becoming greater in January. The minimum is reached in February, after which a slow increase takes place till the size becomes once more normal in April.

Thorax.—I have not made any detailed observations on the thorax, but in general it may be said that there is a very marked furrow down its centre going as far back as the intermediate coxæ. Its typical colour is perhaps black, but all stages from a black suffusion on an ochraceous ground to a complete black thorax are found. All the coxæ are always luteous, however, in my experience.

Abdomen.—The underside of the abdomen is described by Distant (under *Helopeltis antonii*) as "luteous, with a basal spot and the apex black." None of these characters can be considered as constant. The colour varies from ochraceous to luteous through green. A shade of green is by far the most common. The basal spot is not always found. The apex is certainly black in the majority of cases, but in every month there are a number of insects in which it is the same colour as the remainder of the abdomen. This is, probably, in part determined by the length of time from hatching out of the adult, but this will be discussed later in speaking of the female.

The upper part of the abdomen has typically the apex black, and black patches on the next four segments, the patches gradually decreasing in size on each successive segment from the tip. The amount of black is a very variable character. Occasionally the whole upper part of the abdomen is ochraceous, greenish luteous, or green as the case may be, except the tip. Occasionally there is a slight suffusion of black only on several segments. The following is a record of some of the observations made :—

In March, out of twenty samples, thirteen were typical with black patches on four segments as well as the tip, three had black on three segments, two had black on two segments, one had black on one segment, one had only the tip black.

In August, out of twenty samples, twelve were typical, six had black on three, one had black on one, and the remaining one had no black on any segment except the tip.

In September, out of nineteen samples, only ten were typical. Five insects had black on three segments, two insects on two segments, one insect on one segment, while one had no black except on the tip.

December, out of twenty-five samples, seventeen were typical. Two insects had black on *five* segments, three on three segments, one on two segments, and two on one segment only.

Enough has, therefore, been said to show how exceedingly variable is the colouring of the abdomen. From the above observations it would appear probable that there is more black on the abdomen in the colder weather of December to March, but even this is by no means certain.

It is now perhaps possible to draw up a description of the male of *Helopeltis theivora* as occurring on tea in Assam, and show the extent of the variations which may occur under these circumstances. The following is an attempt to do so :—

Part of insect.	Typical characters.	Extent of variation found.
HEAD ...	Broad, deflected in front of eyes, discally and centrally longitudinally incised or sulcated. Antennæ inserted in front of but on a level with the inner margin of the eyes. Minute tubercle just inside insertion of antennæ. Colour—black.	Tubercle not always visible. Colour varies from ochraceous with slight suffusion of black to completely black. Eyes always black. Head often has a lateral ochraceous fascia on each side.
ANTENNÆ ...	Four-jointed.	
	First joint is dark brown with a basal yellowish ring and as a mean is 2·40 mm. (mean) long. It is slightly incrassated near apex.	Length varies from 2·83 mm. (June) to 1·83 mm. (February).
	Second joint is shining brownish black, thinner than base joint and 4·44 mm. (mean) long. Very hairy.	Length varies from 5·57 mm. (May) to 3·57 mm. (February).
	Third joint is similar to second, but slightly thinner, and 4·56 mm. in length (mean).	Length varies from 5·10 mm. (November) to 3·73 mm.
	Fourth joint is similar to the third, but again thinner and 1·63 mm. in length (mean).	Length varies from 1·70 mm. to 1·58 mm.
ROSTRUM ...	Four-jointed, and coloured obscure ochraceous, the tip being dark-brown. It has hairs sparsely scattered over it, and tip is very hairy. In life reaches to intermediate coxæ.	Tip may be almost black.
	Average length— Whole rostrum ... 1·73 mm. Second joint ... ·38 mm. Third joint ... ·38 mm. Tip joint ... ... ·58 mm.	Length of rostrum varies from 1·93 mm. (November) to 1·53 mm. (February).
PRONOTUM ...	Strongly constricted before middle forming a distinct collar. Posterior margin more than twice the length of anterior.	
	Collar is either black or ochraceous or mixed.	Collar tends to be ochraceous in growing season, and black in cold weather.

Part of insect.	Typical characters.	Extent of variation found.
PRONOTUM ...	Remainder of pronotum variable, but most typically black with ochraceous spot on each lateral surface.	Remainder of pronotum varies from entirely black, to black with a wide ochraceous band right across anterior portion. Tendency to be blacker in height of growing season.
HEAD and PRONOTUM.	Combined length 1·53 mm.	Combined length varies from 1·63 mm. (December) to 1·33 mm. (February).
SCUTELLUM ...	Black, Testaceous at apex.	
SCUTELLAR HORN.	Black with ochraceous ring round middle and ochraceous tip. Tip spherical and very hairy. Slightly bent backwards. Length 1·30 mm. (mean).	Colour varies from entirely black to black with a very wide ochraceous ring. Tip may be black. Amount of bending extremely variable. Length varies from 1·53 mm. (October) to 1·03 mm. (January).
WINGS, — HEMELYTRON.	Long, drumstick in shape. Clavus well developed. Corium not hard but membranous, passing into cuneus without division. Length 2·79 mm. (mean). Cuneus, brown, narrow, and 1·14 mm. long (mean). Maximum length of wing, 4·70 mm. Membrane with one irregular vein.	Corium varies in length from 3·13 mm. (January) to 2·50 mm. (February). Wing length varies from 4·87 mm. to 4·60 mm.
HINDWING ...	Colourless with two spur-like veins in membrane.	
LEGS ...	Brown speckled with ochraceous, the bases of the femora distinctly ochraceous. Femora always nodulose, and slightly incrassated at the apex. Length (mean)— Foreleg—Femur (including trochanter) ... 2·02 mm. Tibia ... 2·60 mm. Tarsus ... ·50 mm. Intermediate leg— Femur (including trochanter) ... 2·01 mm. Tibia ... ... 2·55 mm. Tarsus ... ... ·50 mm. Hind leg— Femur (including trochanter) ... 24·7 mm. Tibia ... ... 3·15 mm. Tarsus ... ... ·51 mm.	Foreleg varies from— Femur 2·17 mm. to 1·83 mm. Tibia 2·73 mm. to 2·43 mm. Tarsus ·53 mm. to ·43 mm. Intermediate leg varies from— Femur 2·13 mm. to 1·83 mm. Tibia 2·70 mm. to 2·33 mm. Tarsus ·53 mm. to ·43 mm. Hind leg varies from— Femur 2·83 mm. to 1·93 mm. Tibia 3·40 mm. to 3·00 mm. Tarsus ·63 mm. to ·43 mm.
THORAX ...	Black, with a marked longitudinal furrow down centre as far back as intermediate coxæ. Coxæ always luteous.	Colour varies from a black suffusion on an ochraceous ground to completely black.
ABDOMEN ...	Underside—luteous, ochraceous or green, with a basal spot, and the apex black. Upper side—Apex black and hairy and decreasing black patches on the next four segments. Colour of remainder same as the underside.	Colour varies extremely. Basal spot sometimes missing. Apex sometimes ochraceous. Apex sometimes ochraceous. Number of segments with black patches varies from five to none.

V.—INDIVIDUAL AND SEASONAL VARIATION OF THE FEMALE.

Head.—In typical samples the head is similar in shape to that of the male already described, and possesses a similar longitudinal sulcation. There is also present a tubercle at the base of each antenna. The colour is black with variable amount of ochraceous, the black occasionally only amounting to a slight suffusion. There is often a patch of ochraceous behind the origin of each antenna, and usually a larger or smaller lateral ochraceous fascia.

Antennæ.—These are very similar to those in the male in character and colouring, but differ by having the first joint slightly mottled, and by being much less hairy and much more delicate. While the first joint is longer than in the male, the second and third are considerably shorter. The third joint is slightly shorter than the second. The greater delicacy of the antennæ is shown by the fact that our catchers rarely bring in samples with more than two joints, the third and fourth being broken off very easily. I have never received a single sample caught in the open with the four joints complete.

The colour variations of the antennæ are slight, but the changes in size, according to season, are even more marked than in the male, while the variations among individuals are also very great. As before, I will take the joints of the antennæ separately, and tabulate the results which I have obtained.

(*a*) *First joint of the Antenna.*

Month.	Longest specimen.	Shortest specimen.	General average.
	mm.	mm.	mm.
January ...	2·50	1·83	2·12
February ...	2·33	2·07	2·21
March ...	2·66	2·13	2·33 & 2·36
April ...	2·93	2·23	2·68
May ...	2·83	2·40	2·61
June ...	2·80	2·40	2·60
July ...	2·87	2·37	2·60
August ...	2·77	2·47	2·65
September ...	2 83	2·30	2·60
October ...	2·70	2·40	2·58
November ...	2·77	2·23	2·54
December ...	2·70	2·20	2·42

(*b*) *Second joint of the Antenna.*

Month.	Longest specimen.	Shortest specimen.	General average.
	mm.	mm.	mm.
January ...	4·03	3·17	3·63
February ...	3·97	3·43	3·68
March ...	4·50	3·60	3·90 & 3·86
April ...	4·66	3·53	4·29
May ...	4·70	3·93	4·28
June ...	5·53	3·97	4·38
July ...	5·13	3·93	4·26
August ...	4·50	4·07	4·31
September ...	4·63	3·93	4·28
October ...	4·60	3·83	4·35
November ...	4·50	3·77	4·18
December ...	4·40	3·63	3·99

(*c*) *Third joint of the Antenna.*—(In the months omitted, no insects examined had the third joint intact.)

Month.	Longest specimen.	Shortest specimen.	General average.
	mm.	mm.	mm.
January ...	3·77	3·07	3·44
February ...	...	...	3·40
March ...	3·93	3·30	3·63
April ...	4·27	3·23	3·91
May ...	4·07	3·88	3·98
June ...	4·27	4·10	4·17
July ...	4·10	3·70	3·91
September ...	4·43	3·60	4·03
October ...	4·33	4·23	4·28
November ...	...	...	...
December ...	3·73	3·57	3·66

As has already been stated, the fourth joint was not examined in any of the cases.

The variations in each of these months can be best indicated by the amount the extreme insects are above and below the mean. This is shown in the following table :—

	First Joint.		Second Joint.		Third Joint.	
	Longest. Percentage above mean.	Shortest. Percentage below mean.	Longest. Percentage above mean.	Shortest. Percentage below mean.	Longest. Percentage above mean.	Shortest. Percentage below mean.
	%	%	%	%	%	%
January ...	18·0	12·7	11·0	12·7	9·6	10·8
February ...	5·4	6·4	7·8	6·8	...	...
March ...	12·7	9·7	15·4	7·7	8·3	9·2
April ...	9·3	24·1	8·6	17·7	9·3	17·4
May ...	8·5	8·1	9·8	8·1	2·2	2·5
June ...	7·7	7·7	26·1	9·3	2·4	1·7
July ...	10·4	8·8	20·2	7·7	4·9	5·4
August ...	4·5	6·8	4·4	5·6	...	...
September ...	8·8	11·5	8·1	8·1	10·0	10·7
October ...	4·6	7·0	5·7	12·0	1·2	1·2
November ...	9·0	12·2	7·7	9·8	...	...
December ...	11·6	9·1	10·3	9·0	1·9	2·5

In critically examining the figures, of which these are a summary, there are some points which come out with considerable clearness. The first of these is the extreme irregularity of the figures. In June and July, in particular, some altogether abnormally large antennæ were found. In each case the figures were, however, carefully checked, and they only serve to show to what extent individuals may vary even at the same time of year. It cannot be said that any greater regularity is manifested at the height of the season than in the cold weather. Nor can it be that the irregularities may be explained by the presence of two species. Were this latter the case, there would be present two points in each set where a maximum number of samples would occur, but this is rarely found. Taking two typical months for the first and second joints out of the samples specified in each case, there were the following number at each point :—

First Joint.			Second Joint.		
Length in millimetres.	February (25 samples).	July (22 samples).	Length in millimetres.	February (25 samples).	July (22 samples).
2·00—2·09 ...	1	...	3·40—3·49 ...	2	...
2·10—2·19 ...	8	...	3·50—3·59 ...	6	...
2·20—2·29 ...	9	...	3·60—3·69 ...	7	...
2·30—2·39 ...	7	1	3·70—3·79 ...	3	...
2·40—2·49 ...	...	3	3·80—3·89 ...	4	...
2·50—2·59 ...	...	5	3·90—3·99 ...	3	1
2·60—2·69 ...	.	9	4·00—4·09 ..	...	5
2·70—2·79 ...	...	2	4·10—4·19 ...	...	2
2·80—2·89 ...	...	1·2	4·20—4·29 ...	...	7
			4·30—4·39 ...	...	2
			4·40—4·49 ...	...	3
			4·50—4·59 ...	...	0
			4·60—4·69 ...	...	1
			.....	...	...
			5·13 ...	...	1

There is, therefore, no sign of a mixture of two species in either case, and if the whole of the months are similarly treated, it is found that in no case can the presence of a double maximum (suggesting the probability of admixture of species) be certainly noticed.

The seasonal variation is great, but quite regular. The months from April to December give, in the average, extremely constant measurements. During this time the insects may be said to be flourishing and hence in a normal condition. In January,

February and March they are much smaller, and, though quite active and regularly feeding on the tea when a chance is afforded, are, relatively speaking, in a more or less resting condition. The minimum size is reached in January. The maximum, minimum, and mean length for each joint during the whole season is approximately as follows. The mean length of similar parts of the male antennæ are added for comparison :—

	Female.			Male.
	Maximum.	Minimum.	Mean.	Mean.
	mm.	mm.		mm.
First joint ...	2·87	1·83	2·50	2·43
Second joint ...	5·53	3·17	4·14	4·48
Third joint ...	4·43	3·07	3·50	4·60

Rostrum.—The rostrum is almost exactly similar to the same organ in the male, but is in all cases a little longer. It is coloured obscure ochraceous with a dark brown tip. The whole is sparsely scattered with hairs, except the tip which is quite hairy. The average length of the organ and its joints is as follows :—

Length of rostrum	...	1·89 mm.
„ basal joint (by difference)	...	·43 „
„ second joint	...	·42 „
„ third joint	...	·43 „
„ tip joint	...	·62 „

These figures for the separate joints are only averages for eight months, but it may be said that the three first joints are equal in length, while the tip joint is considerably longer.

As with the male, the rostrum forms one of the most constant parts of the body both in colouring and size. The following table shows the extreme variations and the mean values for the length of the whole rostrum during the year :—

Month.	Largest specimen.	Shortest specimen.	General average.
	mm.	mm.	mm.
January	1·90	1·63	1·78
Februar	1·90	1·73	1·81
March	1·97	1·83	1·89
April	1·97	1·73	1·89
May	2·03	1·70	1·89
June	2·03	1·80	1·92
July	2·03	1·67	1·96
August	2·03	1·83	1·95
September	1·97	1·70	1·90
October	2·03	1·83	1·92
November	1·93	1·83	1·90
December	1·97	1·73	1·88

According to this, the individual variation seems to be considerably greater than that due to season. But even among individuals the large majority lie between the limits of error in measurement.

Pronotum.—Seeing that the colour characters of the pronotum in the female have been relied on in the differentiation of species of *Helopeltis* almost more than any other character (save perhaps the scutellar horn), the study of the differences which occur have a special importance. Distant describes it as "bright shining stramineous or ochraceous, with a sub-apical transverse fascia and the basal area shining black," and this is probably an excellent description of the most common colour arrangement. The shade of ochraceous varies extremely, however, and we have seen every shade from reddish ochraceous to a very light straw colour. The amount of black on this part of the body varies extremely. As in the case of the male, I will first discuss the colouring of the 'collar'* and then that of the remainder.

The colouring of the collar was only observed for a series of samples in February, August and October.

(*a*) In February, out of eight samples, two had the collar completely ochraceous; in five cases there were one or more black spots on an otherwise ochraceous collar, and in the remaining instance the whole of the posterior half was black.

(*b*) In August, out of twenty-five samples, five had the collar entirely ochraceous; in nineteen cases the posterior portion (from one-third to one-half) was black, the remainder being ochraceous, while in one case the whole was black, save for a narrow ochraceous line in the middle.

(*c*) In October, out of twenty-five samples, two had the collar entirely ochraceous; in twenty-one cases the posterior portion was black, while in the remaining two cases there were a few black spots on an ochraceous collar.

(*d*) In November, out of twenty-two samples, eight had the collar entirely ochraceous: in nine cases the posterior portion

* For the meaning in which I use this term see page 289.

was black, while in the remaining five there were a few black spots on an ochraceous collar.

(*e*) In December, out of twenty samples, ten had the collar entirely ochraceous; in five cases the posterior portion was black or at least dark, while in the remaining five there were a few black spots on the ochraceous collar.

Apparently, the typical form has a transverse black fascia, taking up most of the posterior half of the collar, but, as will be seen, the variations are considerable.

The remainder of the pronotum is even more variable in its colour markings. Typically the pronotum may be described as by Waterhouse as being "orange yellow, with a black line near the front margin, the base margined with black." The following observations show to what an extent the amount of black on the pronotum varies.

(*a*) In February, out of twenty-five samples, seven agree with the type described by Waterhouse, in that there is only a narrow marginal patch of black on the posterior of the pronotum. In eighteen cases this posterior black patch spread, in the centre, from one to two-thirds of the length of the pronotum.

(*b*) In August, out of twenty-five samples, twenty-one were typical; three had the black patch from one-third to two-thirds the length; while one sample had no black whatever on the pronotum, simply a slight dark suffusion on the posterior margin.

(*c*) In October, out of twenty-five samples, twenty-three were typical; in one case the black patch was nearly half way to the front of the pronotum, while in the other case the whole was suffused with black throughout.

(*d*) In November, out of twenty-two samples, twelve were typical: in the remaining ten instances the posterior black patch extended over one-third or more of the length of the pronotum.

(*e*) In December, out of twenty samples, eleven were typical; in the remaining nine cases, the posterior black patch extended over one-third or more of the length of the pronotum.

These details suffice to show what has been many times observed, how different is the appearance of the pronotum on the insects gathered in the cold weather and in the height of the season. In fact, the darker, blacker character of the pronotum in the former part of the year, is the first point which strikes the observer who undertakes a study of the seasonal variations of the insect.

We come, in fact, to the conclusion that there is a very great increase in contrast between males and females in the height of the season; the former become darker and the latter become more ochraceous. This is shown by the samples received from the tea estates. In the months from June to December, it is rare that a mistake in classifying the insects as male or female occurs, while during December, January and February in particular, many males are placed along with the female insects.

Head and Pronotum.—The combined length of the head and pronotum has been stated to be about equal in length to the first joint of the antenna. This is not the case, for while the average length of the latter is 2·50 mm., the length of the head and pronotum measured out as follows:—

February	...	1·63 mm.
August	...	1·73 mm.
September	...	1·73 mm.
October	...	1·73 mm.
November	...	1·73 mm.
December	...	1·57 mm.

Scutellum.—The scutellum is usually ochraceous, with a darker shade than the pronotum, or as Distant expresses it "ochraceous, more or less suffused with black." I have not been able to examine in detail the divergences from this typical colour. The scutellar horn is, however, as with the male, a point of considerable interest. Distant describes it as "long, black, piceous at apex, and also as more or less distinctly curved backward." With regard to the bending, it may at once be said that it is almost always very much more curved than the horn of the male. While in many of the latter sex, it is difficult to detect any bending at all, in the female the curve is nearly always very

distinct, but the amount of bending is very variable. As with the male, I have attempted to classify the amount of bending, and the following table shows the percentage of "slightly bent," "moderately bent," and "very bent" horns in the catches for several months:—

Month.	Scutellar Horn.		
	Slightly or very slightly bent.	Moderately bent.	Very bent.
	Per cent.	Per cent.	Per cent.
January ...	15	58	27
February ...	12	50	38
March ...	26	42	32
August ...	4	83	13
September ...	21	38	41
October ...	5	71	24

I do not attribute any very great accuracy to the determination of the amount of bending, as the above were noted in at different times, extending over a period of nearly six months, but they suffice to indicate the extreme variability of the backward curve in the scutellar horn.

The colour is equally variable, and the form described as typical by Waterhouse does not occur at all commonly. In fact, one may say that most frequently the horn has an ochraceous ring round the centre and a tip ochraceous to luteous in colour. The following cases illustrate the variations.

(*a*) In February, out of eighteen insects, eleven were as just described; four were completely black, except for a luteous tip; one was black throughout, while two were ochraceous, except for quite narrow rings of black at the base and just under the knob.

(*b*) In August, out of twenty-three insects, sixteen were as described above. In five cases there was only a narrow ring of black at the base and under the tip; in one case all was black, except the tip, and in one case also there was an ochraceous ring, but the tip itself was black.

(*c*) In October, out of twenty-two, nineteen were as described above; one was, except for a narrow patch at the bottom

and under the knob, completely ochraceous; one was black entirely, except for an ochraceous tip, and one had an ochraceous ring, but the tip was black.

It is, therefore, very evident that the colouring of the scutellar horn varies enormously, but on the whole is very similar to that of the same organ in the male.

The length of the scutellar horn has only been determined in a few cases, and the results are not very reliable. The averages for April, May, June and July are respectively 1·39 mm., 1·40 mm., 1·61 mm., 1·55 mm., showing that the horn, in common with the other parts of the body, increases in size during the season most favourable to the development of the insect.

These results are quite sufficient to show that the scutellar horn, owing to its extremely variable character, is quite unsuitable as a determining factor in classifying the species of *Helopeltis*, and that this applies equally to that of the female and to that of the male.

Wings.—The description of the wings already given under the male applies almost equally to those of the female, and therefore need not be repeated. They are, however, larger in the female, and measurements have been made of the hemelytron at all seasons.

The maximum length of the hemelytron and of the corium of the same individual came out as follows :—

Month.	Maximum length of forewing.	Length of corium.
	mm.	mm.
January ...	5·07	3·10
February ...	5·36	3·33
March ...	5·23	3·20
August ...	5·13	3·20
September ...	5·60	3·37
October ..	5·33	3·20
November ...	5·47	3·20
December ...	5·27	3·07

These are only, however, the measurements of individual samples, and hence have no value as indicating the mean for their months.

The average length of the corium in the several months was as follows :—

Month.	Longest specimen.	Shortest specimen.	General average.
	mm.	mm.	mm.
January	3·40	2·87	3·11
February	3·40	2·87	3·19
March	3·40	3·10	3·28 & 3·26
April	3·50	3·06	3·32
May	3·50	3·07	3·31
June	3·43	3·07	3·27
July	3·50	3·00	3·26
August	3·33	2·97	3·23
September	3·40	2·93	3·21
October	3·43	2·97	3·24
November	3·50	3·10	3·25
December	3·37	2·93	3·19

These results are very constant. The monthly means do not vary more than $6\frac{3}{4}$ per cent. Individuals vary considerably more than this and, hence, as with the male, we have to do more with an individual than a seasonal variation. The differences between the largest and smallest wings in January and February is greater than in any other month, indicating, as remarked with the male, that the colder weather and the then condition of life has a tendency to destroy uniformity.

The relative length of the corium and cuneus has been determined also for all samples for three months (August, November and December). The figures gave (mean) 3·22 mm. for the corium and 1·33 mm. for the cuneus, or a relationship of slightly less than $2\frac{1}{2}$ to 1.

Legs.—No better description of the legs of the female can be given than that of Distant :—"Femora dark brown, mottled with ochraceous, and with a distinct pale annulation near base ; tibiæ ochraceous, speckled with fuscous." The three legs are extremely similar in form and colouring, and as with the male, the fore and intermediate legs are approximately the same size and smaller than the hind leg. The colouring is very constant. The femora are distinctly nodulose and slightly incrassated at the apex. The trochanter has been measured with the femur. The tibia is very hairy at the lower part, and the structure of the tarsus precisely similar to that of the male.

I have, in many months, measured in individual insects, the fore, intermediate and hind legs, and the following are the figures thus obtained :—

Month.	Fore Leg.			Intermediate Leg.			Hind Leg.		
	Femur.	Tibia.	Tarsus.	Femur.	Tibia.	Tarsus.	Femur.	Tibia.	Tarsus.
	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.
January	1·77	2·33	·43	1·73	2·27	·47	2·20	2·90	·47
February ...	1·93	2·57	·50	1·87	2·50	·50	2·37	3·13	·53
March ...	1·93	2·47	·47	1·97	2·43	·47	2·40	3·03	·50
August ...	2·10	2·73	·53	2·10	2·73	·53	2·63	3·43	·57
September ...	2·20	2·90	·50	2·20	2·80	·50	2·53	3·67	·57
October ...	2·10	2·77	·53	2·10	2·77	·53	2·57	3·43	·57
November ...	2·00	2·63	·47	2·00	2·63	·47	2·53	3·33	·50
December ...	2·07	2·77	·47	2·07	2·73	·47	2·57	3·43	·50

All the legs therefore share the seasonal reduction in size which takes place in the early months of the year, and which reaches its extreme in January. This is more completely indicated by the following larger series of observations on the hind leg :—

Month.	Length of Femora.			Length of Tibia.			Length of Tarsus.		
	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.	Maximum.	Minimum.	Mean.
	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.	mm.
January ...	2·60	2·10	2·33	3·33	2·77	3·07	·53	·43	·49
February ..	2·50	2·10	2·37	3·37	2·77	3·09	·53	·47	·50
March ...	2·63	2·30	2·50	3·43	2·97	3·24	·57	·43	·51
April ...	2·80	2·40	2·69	3·70	3·07	3·49	·56	·50	·51
May ...	2·87	2·57	2·73	3·77	3·30	3·52	·57	·50	·53
June ...	2·90	2·53	2·72	3·83	3·27	3·53	·60	53	·55
July ...	2·93	2·53	2·73	3·77	3·33	3·51	·57	·53	·54
August ...	2·87	2·43	2·71	3·70	3·27	3·50	·57	·53	·56
September	2·77	2·43	2·62	3·67	3·20	3·44	·57	·50	·54
October ...	2·83	2·33	2·66	3·70	2·87	3·47	·60	·50	·55
November ...	2·83	2·43	2·57	3·70	2·90	3·35	·53	·50	·51
December ...	2·67	2·33	2·52	3·53	3·13	3·30	·57	·47	·51

These figures indicate that the extremes of individual variation are—

(1) for the femora—2·93 mm. to 2·10 mm. or sixteen per cent above or below the mean.

(2) for the tibiæ—3·83 mm. to 2·77 mm. or over sixteen per cent above or below the mean.

(3) for the tarsus—·60 mm. to ·43 mm. or nearly seventeen per cent above or below the mean.

The seasonal variation of the mean is also very great. From sizes of 2·33 mm., 2·77 mm., and ·49 mm. for the femur, tibia and tarsus respectively in January, a rise occurs to 2·72 mm., 3·53 mm., and ·55 mm. respectively in June. One may note the curious fact that apparently the female both reaches the minimum and maximum sizes earlier in the season than the male. The figures are however very constant from April till October.

Thorax.—My observations on the thorax indicate that it is generally wholly ochraceous with the slightest suffusion of black in places. There is, as with the male, a marked furrow from the anterior margin to the intermediate coxæ; in fact, just as far as the rostrum extends in life. The coxæ are always luteous.

Abdomen.—The abdomen varies from ochraceous to almost luteous in colour, the prevailing tint being a light green. This is, however, marked with dark brown on several segments both on the upper and under side.

The underside bears a corneous ovipositor arising from the sixth abdominal segment, as described by Dudgeon, and extends to the final segment of the abdomen. The section from which it arises and the two following ones, as well as the apex, are usually dark-brown or black. This is by no means invariably the case, and in breeding these insects I fell upon the reason for the differences. Immediately after the last moult, I found that the females were ochraceous throughout, without a trace of black or dark-brown anywhere on the body except the eyes. This condition of things lasted a few hours only, and gradually the more normal colour was developed. Under these conditions even the ovipositor was ochraceous. It is evident, therefore, that unless one knows the age of a sample from the final moult, the amount of black on the insect has no value as a means of determining species. Since one can never tell the age of the insect in caught samples, it follows that the description of the spotting with dark-brown or black in any particular samples is almost if not quite useless.

This applies to the whole of the insect, including the abdomen, but as I have made careful notes of the amount of black on the upper side of the abdomen in a large number of cases, it may be

worth while to record them. Typically the tip is black, and two more segments, and there are black spots decreasing in size on the next two segments. The posterior margins of the black segments are often, but not always, narrowly ochraceous or green. To show to what extent individuals vary, the observations for August and October may be detailed.

(*a*) In August, out of twenty-four insects, eight had the typical characters just described, eight had black patches on five segments beside the tip, and one had black markings only on three sections. The remainder (seven) had no black anywhere, both abdomen and tip being ochraceous or greenish in colour.

(*b*) In October, out of twenty-two insects, eight had typical characters, six had black on five segments beside the tip, three with black on three segments, two with black on two segments, and one with no black on any section. Two were quite irregularly spotted.

(*c*) In November, out of twenty-two insects, nine were typical, seven had black on five segments beside the tip, while the remainder had no black anywhere.

(*d*) In December, among twenty samples examined, nine were typical, two had black on five segments beside the tip, and one had black on only three segments. Four were entirely ochraceous, and the remainder had a slight dark suffusion on the tip and four segments.

We may perhaps now draw up a description of the female of *Helopeltis theivora* as occurring in Assam and feeding on tea similar to that already given for the male, and show the extent of the variations which may occur :

Part of Insect.	Typical characters.	Extent of variation.
HEAD ...	Shape as with male. Antennæ inserted as with male. Minute tubercle just inside insertion of antennæ. Colour—indefinite mixture of brownish ochraceous and black, under sides generally lighter than above. Luteous fascia on each side of head.	Colour varies from wholly ochraceous (except eyes) to almost completely black.

Part of Insect.	Typical Characters.	Extent of Variation.
ANTENNÆ ...	Four jointed. Second, third, and fourth (?) joints much less hairy than male.	Hairiness very variable.
	First joint—brown, somewhat mottled, yellowish at base and (as a mean) 2·50 mm. long. Slightly incrassated at apex.	Length varies from 2·93 mm. (April) to 1·83 mm. (January).
	Second joint—brownish black, shining, thinner than base joint, and 4·14 mm. long (mean).	Length varies from 5·53 mm. (June) to 3·17 mm. (January).
	Third joint—similar to second, but slightly thinner. Length (mean)—3·47 mm.	Length varies from 4·43 mm. (September) to 3·07 mm. (January).
	Fourth joint—not observed.	
ROSTRUM .	Colouring and shape as with male. In life reaches to intermediate coxæ.	
	Average length— Whole rostrum ... 1·89 mm. Second joint ... ·41 mm. Third ,, ... ·43 mm, Tip ,, ... ·62 mm,	Length of rostrum varies from 2·03 mm. to 1·63 mm.
PRONOTUM ..	Shape as in male.	
	Collar has transverse ochraceous fascia on posterior half.	Varies from completely ochraceous to having the whole of the posterior half black.
	Remainder of pronotum ochraceous with the base margined with black.	The tint of the ochraceous portion is very variable, from reddish ochraceous to light stramineous. The amount of black varies from nothing to a posterior patch more than half covering this section of pronotum.
HEAD AND PRONOTUM.	Combined length—1·75 mm. ...	Varies at least from 1·87 mm. to 1·57 mm.
SCUTELLUM ...	Ochraceous, darker than pronotum.	
SCUTELLAR HORN.	Black with ochraceous ring round middle and ochraceous to luteous tip.	Colour varies from entirely black, to ochraceous with black ring at base and under tip, and luteous tip.
	Tip spherical and very hairy.	
	Bent backwards, usually more than with male.	Bending very variable.
	Length—1·48 mm. mean ...	Length varies from 1·61 mm. to 1·39 mm.
WINGS,-HEMELYTRON.	Shape, colouring and characters as in male.	
	Corium length—3·24 mm. (mean)	Corium varies from 3·50 mm. to 2·87 mm.
	Cuneus length—1·33 mm. (mean).	
	Maximum length—5·3 mm. (mean) ...	Maximum length varies from 5·60 mm. to 5·13 mm.
	(The figure for the cuneus is for three months only—August, November and December).	
HINDWING ...	As with male, but slightly larger.	

Part of Insect.	Typical characters.	Extent of variation.
LEGS ...	Colouring and shape as in male.	
	Length (mean)—	Foreleg varies from—
	Foreleg—	
	Femur (with trochanter) 2·00 mm.	Femur ... 2·17 mm. to 1·77 mm.
	Tibia ... ... 2·63 ,,	Tibia ... 2·90 ,, to 2·33 ,,
	Tarsus ... ... ·49 ,,	Tarsus ... ·53 ,, to ·43 ,,
	Intermediate leg—	Intermediate leg varies from—
	Femur (with trochanter) 2·00 mm.	Femur ... 2·20 mm. to 1·73 mm.
	Tibia ... ... 2·58 ,,	Tibia ... 2·80 ,, to 2·27 ,,
	Tarsus ... ... ·50 ,,	Tarsus ... ·53 ,, to ·47 ,,
	Hind leg—	Hind leg varies from—
	Femur (with trochanter) 2·61 mm.	Femur ... 2·93 mm. to 2·10 mm.
	Tibia ... ... 3·39 ,,	Tibia ... 3·83 ,, to 2·77 ,,
	Tarsus ... ... ·53 ,,	Tarsus ... ·53 ,, to ·43 ,,
THORAX ...	Ochraceous, with slight suffusion of black in places.	
	Marked furrow from anterior margin to intermediate coxæ.	
	Coxæ luteous.	
ABDOMEN ..	Underside luteous ochraceous or green, with apex and three adjoining segments black.	Apex and all the remaining segments may be the same colour as the rest of the abdomen.
	From the sixth abdominal segment rises the ovipositor.	
	Ovipositor is corneous, and extends to the terminal segment; usually black.	Ovipositor sometimes ochraceous.
	It is double, and thus two eggs are usually laid at once. Edges of tip of ovipositor serrated. Length 1·5 mm. (approx.).	
	Upper side.—Apex black, next two segments black, and then decreasing black patches and next two segments. Colour of remainder as with the underside.	The colouring of the abdomen is very variable.
	Anus—about ·3 mm. in diameter.	

VI.—VARIATIONS DUE TO LOCALITY.

We have so far considered the variations which are induced by casual circumstances leading to alteration in the morphological characteristics of the *Helopeltis theivora*, and also the variations induced by changes of season. There remain two further circumstances which may lead to variation, namely, change of locality and change of food. I have been able to investigate both of these points to a small and insufficient extent, but the data so far obtained have a certain value, and as it will probably not be possible to continue the detailed study, they may be cited here.

With regard to the effect of locality, I have been able to collect samples of *Helopeltis* insects from Assam (already described); the lower part of the Darjeeling district (Singla), at an elevation of from 1,200 to 3,000 feet; from Koomber, Cachar, at an elevation of under 150 feet; and from Ellenbarrie in the Duars, at about five hundred feet above the sea. They have only been obtained for a month in each case at the height of the season, but the mean figures for the months at this time of the year have proved so constant in the former cases that it seems to matter little, whether the insects be taken in August, September, or October. I will give here the mean figures for my measurements in each case, and only call attention to any point if it is beyond the range of variation already laid down :—

Males.

Length of parts of Insect.	Behalli, September.	Singla, September.	Koomber.	Ellenbarrie, September.
(MEAN FIGURES.)				
Antennæ—	mm.	mm.	mm.	mm.
1st joint	2·53	2·56	2·45	2·48
2nd ,, ...	4·60	4·91	4·44	4·47
3rd ,, ...	4·76	4·59	4·59	4·58
Forewing, length of Corium ...	2·78	2·95	2·77	2·78
Rostrum	1·76	1·85	1·92	1·76

Males.—(Contd.)

Length of parts of Insect.	Behalli, September.	Singla, September.	Koomber.	Ellenbarrie, September.
(MEAN FIGURES.)				
Hind Leg—	mm.	mm.	mm.	mm.
Femur	2·55	2·59	...	2·53
Tibia	3·21	3·27	.....	3·16
Tarsus	·54	·52	.....	·51
Scutellar Horn	.....	1·45	.....	1·37*
(INDIVIDUAL.)				
Head and Pronotum	1·57	1·63	.....	1·47
Forewing, maximum length	4·60	5·04	4·40	4·73
Foreleg—				
Femur	2·17	2·17	.. ...	2·10
Tibia	2·70	2·90	.....	2·63
Tarsus	·50	·53	.....	·50
Intermediate leg—				
Femur	2·13	2·17	.. ...	2·10
Tibia	2·70	2·90	.....	2·63
Tarsus	·50	·53	.....	·50

Among these there are only a very few measurements which call for note. The limits of variation in nearly every case are well within those laid down already for the insects, though not necessarily within the limits previously obtained for the same month. One strange figure, however, calls for notice. In one case at Singla, the second joint of the antenna reached the huge length of 6·33 mm.,—the highest for the whole season obtained at Behalli being only 5·57 mm. No explanation can be attempted and the remainder of the insects were well within the previously observed limits.

Females.

Length of parts of Insect.	Behalli, September.	Singla, September.	Koomber.	Ellenbarrie.
(MEAN FIGURES.)				
Antenna—	mm.	mm.	mm.	mm.
1st joint	2·60	2·33	2·54	2·60
2nd joint	4·28	3·90	4·23	4·23
3rd joint	4·03	3·63	.....	4·00
Forewing, length of Corium	3·21	3·28	3·24	3·24
Rostrum	1·90	1·89	1·90	1·92
Hind Leg—				
Femur	2·62	2·50	2·78	2·73
Tibia	3·44	3·24	3·52	3·49
Tarsus	·54	·51	·57	·53
Scutellar horn	.....	.. ...	1·43	1·53*
(INDIVIDUAL.)				
Head and Pronotum	1·87	.....	1·63	1·67
Forewing, maximum length	5·60	5·23	5·27	5·33
Foreleg—				
Femur	2·20	1·93	2·23	2·17
Tibia	2·90	2·47	2·90	2·60
Tarsus	·50	·47	·53	·50
Intermediate leg—				
Femur	2·20	1·97	2·23	2·13
Tibia	2·80	2·43	2·90	2·60
Tarsus	·50	·47	·53	·47

* Individual only.

Among these females it will at once be noticed that the Singla insects, being from a higher elevation, are smaller than the others, but are still well within the limits of variation for the species as found in Assam.

The colouring was almost if not quite similar in the different localities. If anything, those from the higher elevations at Singla were more ochraceous (especially in the abdomen) and less green than those in the plains, but it is certainly not possible to speak confidently on the point. And if collecting the insects attacking tea at widely separated points in the tea districts of North-East India be a guarantee of obtaining every type of insect, it may be said with confidence that there is now only one species of Helopeltis attacking tea in this area.

This point is of considerable interest because Watt, in a very interesting and productive tour, which he made in Assam in 1895, found two insects attacking tea which he called the 'red tea mosquito' and the 'green tea mosquito.' The former was principally found on the south bank of the Brahmaputra; the latter on the north. I have never been able to get an authentic specimen of these two supposed species, but in view of the figures given and of the gradations of colour which are seen to occur in every garden when close study is given to the question, one would be inclined to fancy that the differences noted by Watt were within the range of variation which we have noted on the same place, if he had not found also differences in hairiness, and it is a great pity that his specimens have disappeared, as my search during several years for the orange red type that he describes in Assam has been quite futile.

VII.—VARIATIONS DUE TO CHANGE OF FOOD.

There only remains the variation caused by change of food to be dealt with. And here I am sorry to say that my observations are limited to some samples supplied by Mr. R. Pantlung, Superintendent of the Government Cinchona Plantations, Bengal, caught feeding on Cinchona. The figures obtained for these and the notes made on them are, however, of some interest, though I had hoped to have had samples also from Cacao. The figures are as follows, compared with those obtained for tea at Behalli for the same month.

Males.

Length of parts of Insect.	Tea.	Cinchona.	
	Behalli October.	Mungpoo A.	Mungpoo B.
	mm.	mm.	mm.
(Average.)			
Antenna—			
1st joint	2·51	2·56	2·47
2nd joint	4·59	4·60	4·48
Rostrum	1·76	1·75	1·72
Forewing—			
Corium	2·79	2·85	2·83
Cuneus	.....	1·19	1·12
Hind leg—			
Femur	2·51	2·57	2·52
Tibia	3·14	3·21	3·16
Tarsus	·54	·50	·51
(Individual.)			
Foreleg—			
Femur	2·05	2·20	2·10
Tibia	2·67	2·73	2·67
Tarsus	·50	·53	·50
Intermediate leg—			
Femur	2·05	2·17	2·03
Tibia	2·53	2·63	2·67
Tarsus	·50	·50	·50
Forewing, maximum length	4·73	4·73	4·90
Scutellar horn	1·37 (mean)	1·40	1·27

Females.

Length of parts of Insect.	Tea.	Cinchona.	
	Behalli October.	Mungpoo A 2,700 ft.	Mungpoo B 4,000 ft.
(Average.)			
Antenna—	mm.	mm.	mm.
1st joint	2·58	2·65	2·60
2nd joint	4·35	4·30	4·32
Rostrum	1·92	1·95	1·96
Forewing—			
Corium	3·24	3·39	3·33
Cuneus	.....	1·43	1·38
Hind leg—			
Femur	2·66	2·75	2·72
Tibia	3·47	3·52	3·53
Tarsus	·55	·53	·55
(Individual.)			
Foreleg—			
Femur	2·10	2·23	2·20
Tibia	2·77	2·87	2·63
Tarsus	·53	.....	·53
Intermediate leg—			
Femur	2·10	2·23	2·27
Tibia	2·77	2·83	2·87
Tarsus	·53	.....	·53
Forewing Maximum length	5·33	5·84	5·43

These figures call for no remark. The change of food from tea to cinchona seems to have led to no modification in the structure of the *Helopeltis* insects, and their colouring remains the same as it was before. The differences in the above figures are well within the limit of variation already determined for the insect as it occurs on tea.

VIII.—RELATIONSHIP BETWEEN HELOPELTIS THEIVORA AND HELOPELTIS ANTONII.

During the course of the present investigation, Mr. E. E. Green, the Government Entomologist of Ceylon, very kindly supplied me with samples of *Helopeltis antonii* found on both tea and cacao in that island. It is, of course, well known that the place of the *H. theivora* of India as a pest of tea is taken by *H. antonii* in Ceylon, and it was interesting to ascertain what were the differences between the two insects, and which of these were constant.

The Ceylon insect is thus described by Distant.

"*Helopeltis antonii.*

"*Male.*—Head and pronotum black, anterior margin of pronotum narrowly obscurely ochraceous; rostrum obscure ochraceous, more or less suffused with fuscous, prominently so at apex; antennæ shining piceous, ochraceous at base; scutellum black, testaceous at apex; hemelytra pale, olivaceous fuscous; legs brown, speckled with ochraceous; bases of femora distinctly ochraceous; abdomen beneath luteous with a basal spot and the apex black; scutellar horn nearly straight and perpendicular.

"*Female.*—Pronotum, and most of the scutellum purplish red, the transverse constriction to the first sometimes piceous.

"Length, 6 to $7\frac{1}{2}$ millim."

It is evident that almost all this description, with the exception of the purplish red character of the female pronotum, and the straight character of the scutellar horn (and both of these I have already shown to be variable characters), might almost equally well apply to *H. theivora*, and it became of great interest to determine where the difference really lay, if such difference really existed. After my examination there remains, no doubt,

whatever of the distinctness of the two species, but the points of real difference are entirely missed in the above description. The diagram of the scutellar horn, which accompanies it, is also quite unnatural.

Before going on to consider the differences between the Indian and the Ceylon insects, I may note that the latter are very similar, whether from cocoa in November 1906, or from tea in February 1907, the differences being well within the range already given for the seasonal variations of *H. theivora*. To take a series of typical measurements (in each case except those in brackets), the average of a number, we have as follows :—

Length of	February 1907. (From Tea.)		November 1906. (From Cocoa.)	
	Male.	Female.	Male.	Female.
	mm.	mm.	mm.	mm.
Antenna—				
1st joint	2·27	2·45	2·20	2·31
2nd joint	4·14	4·16	4·19	4·24
3rd joint	(3·43)	.....	(3·57)	2·83
Forewing—				
Corium	2·81	3·29	2·89	3·46
Cuneus	·99	1·21	1·14	1·36
Hind leg—				
Femur	2·45	2·67	2·59	2·77
Tibia	3·06	3·39	3·14	3·51
Tarsus	·52	·52	·51	·52
Rostrum	1·79	2·00	1·82	2·07

The principal points in which the Ceylon insect (*Helopeltis antonii*) differs from *Helopeltis theivora*, are as follows :—

Antenna.—In the males of the two insects the length of the several joints is as follows :—

Males.

	Helopeltis Theivora.			Helopeltis Antonii.		
	Average.	Variations.		Average.	Variations.	
	mm.	mm.	mm.	mm.	mm.	mm.
1st joint	2·40	2·83	to 1·83	2·23	2·40	to 2·07
2nd joint	4·44	5·57	to 3·57	4 17	4·43	to 3·97
3rd joint	4·56	5·10	to 3·73	.....	3·57	to 3·43
4th joint	1·53	1·70	to 1·58	.....	.....	.....

Here it will be seen that though the length of the first and second joints are not very dissimilar in the two insects, in *Helopeltis antonii*, the third joint is much shorter than the second, while it is at least equal with *H. theivora*. A similar shortness of the third joint is shown in the female :—

Females.

	H. theivora. Average.	*H. antonii.* Average.
	mm.	mm.
1st joint	2·15	2·38
2nd joint	4·14	4·19
3rd joint	3·47	2·87

In colouring of the antenna there was no obvious difference.

Rostrum.—On the whole, the rostrum appears to be slightly longer with the Ceylon insect, but the relative length of the joints is the same.

Pronotum.—The pronotum in the male, as described by Distant for *H. antonii*, might possibly apply to some of the *H. theivora* from India, but would certainly not do so for the Ceylon insect. I should describe the latter as follows :—Collar is generally ochraceous, with posterior margin black. Remainder of pronotum reddish ochraceous with anterior margin black, and slight suffusion of black over the central posterior portion.

The pronotum of the female *H. antonii* might be thus described :—Collar is generally ochraceous, but has the posterior portion black ; remainder of pronotum has anterior margin black, otherwise reddish ochraceous, with slight suffusion of black in the posterior centre.

Of course, in each case, though this description gives the typical colouring, yet, as with *H. theivora*, there are considerable variations.

Scutellar horn.

Male. Length	...	*Helopeltis theivora*	... 1·53 mm. to 1·03 mm.
		Helopeltis antonii	... 1·20 mm. to 1·13 mm.
Female. Length	...	*Helopeltis theivora*	... 1·61 mm. to 1·39 mm.
		Helopeltis antonii	... 1·47 mm. to 1·43 mm.

No difference can, therefore, be made (as imagined by Waterhouse), out of the length of the scutellar horn. As regards the amount of bending in the horn, there is little difference in the male between the two species, but much on the average, in the female. *Helopeltis theivora* (female) almost always has a very curved horn, that of *H. antonii* is hardly curved, but this is sufficiently variable to make it inadvisable to make it a primary point in classifying the species. The coloration of the scutellar horn is considerably different in all the specimens I have examined in the two species ; that of *H. theivora* has been already described. In both the male and the female of *H. antonii* the typical colour is black, with a luteous base, and a tip varying from luteous to dark ochraceous. It is, however, very variable, the hole of the organ being occasionally ochraceous in colour, with at most a very slight dark suffusion.

There is nothing either in the wings or the legs on which any differentiation can be made. The femora in *H. antonii* are usually, however, less speckled with ochraceous than in *H. theivora*, being almost a uniform dark brown colour with the exception of a broad luteous band at the base.

The colouring of the abdomen is quite different in the two insects, though how far this is a definite character in the Ceylon insect I am not sure. In the cases I have examined, the abdomen in a typical male is greenish to greenish-luteous in colour, the tip segment being black and from three to five others, the remainder having a few spots of black on them. There is also a black spot at the side of the abdomen on the two or three segments at the base. The female has a much more reddish-yellow abdomen, but the black markings on the dorsal surface are almost exactly the same ; there are, however, lateral black spots on almost every segment, decreasing in amount from the base towards the apex.

The coloration of the underside of the thorax varies extremely from ochraceous to black, and the coxæ may be either luteous or black. On the whole, I think, that the differentiation

between these species will have to depend on the following characters :—

(1) The length of the third joint of the antenna relative to the second.

(2) The colouring of the pronotum in the male.

(3) Subsidiarily on the curvature of the scutellar horn in the female.

(4) Subsidiarily, on the colouring of the abdomen.

It is a great pity that, except for the first of these, the differentiation depends on such characters as colouring and curvature, and before these points can be regarded as satisfactorily established as constant enough for the purpose, large numbers of the insect collected in every month in the year would have to be examined. The first item, however, seems quite definite as between the two species now under discussion.

IX.—NEW SPECIES OF HELOPELTIS.

In going through the samples received from the Cinchona plantation at Munsong in British Bhutan, and twenty miles from Mungpoo where those already recorded were obtained, it was found that the whole of the samples were markedly different from any that had previously been examined. The whole of the insects had a reddish ochraceous tinge, which marked them off from the ordinary form completely. One or two of these insects were afterwards found among the catch sent me from Mungpoo itself. This was at first thought to be a modification in colouring induced by changes of conditions, but on close examination, it was found that the insect was marked off completely by the structure of the antennæ. The first joint of these was very short and incrassated throughout almost the entire length : the second joint was also much shorter than usual with *Helopeltis theivora*. Further differences which then became evident were the bright red colouring of the apex and inner margin of the cuneus, quite different and characteristic markings of the pronotum, and the differently shaped and luteous character of the scutellar horn. I would not insist in the latter two points in the absence of the first, and place principal reliance in differentiating these insects from those described hitherto on the different structure of the antennæ.

The following are measurements obtained with this insect. I regret that paucity of material prevented me from dissecting and measuring more than three males and five female insects. The ordinary *Helopeltis theivora* on Cinchona is placed side by side for comparison.

Length of parts of Insect.	Male.		Female.	
	Helopeltis theivora on Cinchona.	New insect on Cinchona.	Helopeltis theivora on Cinchona.	New insect on Cinchona.
(Average.)	mm.	mm.	mm.	mm.
Antenna—				
1st joint	2·47	·97	2·60	1·13
2nd joint	4·48	3·00	4·32	3·22
3rd joint	.....	.....	.....	2·71
Rostrum	1·72	1·60	1·96	1·73
Forewing—				
Corium	2·83	2·90	3·33	3·50
Cuneus	1·12	1·17	1·38	1·35
Hind leg—				
Femur	2·52	2·50	2·72	2·76
Tibia	3·16	3·13	3·53	3·51
Tarsus	·51	·57	·55	·61
(Individual.)				
Fore leg—				
Femur	2·10	1·93	2·20	2·00
Tibia	2·37	2·33	2·63	2·63
Tarsus	·50	·50	·53	·57
Intermediate leg—				
Femur	2·03	2·10	2·27	2·20
Tibia	2.67	2·43	2·87	2·80
Tarsus	·50	.....	·53	·57
Forewing, maximum length ...	4·90	4·70	5·43	5·74
Scutellar horn	1·27	1·27	.....	1·57

In almost every point, therefore, except the antennæ, the new insect from Cinchona at Munsong is extremely close in size and proportion to *Helopeltis theivora*. Yet in this point the difference is so marked that I think we are justified in separating it from the former. At first I thought it might be the long lost *Helopeltis fabriculosa* of Bergroth. The latter, however, certainly no more agrees with the new insect than does *Helopeltis theivora*, in fact less so. The following are points in the description of *H. fabriculosa* (female) which do not agree :—

(1) The first joint of the antennæ extends a little beyond the apex of the scutellum. In the new insect it does not reach the posterior margin of the pronotum.

(2) "Rostrum nearly reaching beyond the last pair of feet." In the new insect it only extends to the intermediate coxæ.

(3) "Thorax.....with a transverse basal band more extended forward to middle, and transverse streak placed a little before the apex black." This would agree with some of the variations of *Helopeltis theivora*, but certainly does not agree with the new insect.

(4) "Cuneus piceous." In the new insect the cuneus both in the male and female is largely bright red in my samples.

It is evident, therefore, that the new insect is no more *Helopeltis febriculosa* than it is *Helopeltis theivora*. In fact, it agrees with no described species of *Helopeltis* that I have been able to trace, and it seems, therefore, justifiable to describe it as new. I name it, therefore, *Helopeltis* cinchonæ* and describe it as follows :—

HELOPELTIS CINCHONÆ *n. sp.*

Male.—Three samples, caught in October, examined.

Parts of Insect.	Typical characters.	Variation noticed.
HEAD ...	Shape as for the genus, black all over. No tubercle at base of antennæ.	
ANTENNÆ ...	Four-jointed. *First joint*—Stramineous—luteous speckled with black, nodulose, and incrassated during most of the length. Length—·97 mm. *Second joint*—Dark brown with black tip. Length—3·00 mm. *Third joint*—Dark brown, extreme base and apical third black, slightly thickened at apex. Length—not observed. *Fourth joint*—not observed.	
ROSTRUM ...	Four-jointed, Ochraceous-luteous, with dark brown. Tip—Length—1·60 mm. 2nd joint—·33 mm. 3rd joint—·37 mm. 4th joint—·50 mm.	
PRONOTUM ...	Shape as for genus. Wholly black above and below.	
HEAD AND PRONOTUM.	Length—1·37 mm. (?)	
SCUTELLUM ...	Black.	
SCUTELLAR HORN.	Black about a quarter of the length from the bottom. Above this is luteous throughout, except for extremely narrow ring just below the tip. As stout as with *Helopeltis theivora*. All my samples very slightly bent. Length—1·27 mm. The clavate tip is not nearly so large relatively to the thickness of the horn as with *H. theivora*.	

* I place this species in the genus *Helopeltis* because the general relations of the insect seem to bring it very close to *Helopeltis theivora*. If the relative length of the head and pronotum and the first joint of the antenna be thought to be of generic importance, it would form a new genus. I hardly think that they should be considered as such in spite of the original definition of the genus by Signoret.

Male.—Three samples, caught in October, examined—(*contd.*)

Parts of Insect.	Typical characters.	Variation noticed.
WINGS, HEMELYTRON.	As in *H. theivora*, but slight suffusion of black throughout. Cuneus has apex and inner portion bright red, extending sometimes into the vein in the membrane. Corium—Length—2·90 mm. Cuneus—Length—1·17 mm. Maximum length—4·70 mm.	
HINDWING ...	Extremely like *H. theivora*. One additional diagonal vein, separated, in the inner portion of membrane.	
LEGS ...	*Hind leg*—Dark femur, with light coloured ring at base, and with variable quantities of reddish ochraceous. Tibia and tarsus ochraceous, former very hairy towards tip, and latter hairy. Formation of tarsus similar to *H. theivora* Femur—2·50 mm. Tibia—3·13 mm. Tarsus—·57 mm. *Intermediate & Fore legs*—Not unlike hind leg, but less dark in femur. Length—Intermediate. Fore. Femur— 2·20 mm. 2·00 mm. Tibia— 2·80 mm. 2·63 mm. Tarsus— ·57 mm. ·57 mm.	
THORAX ...	Entirely black. Coxæ luteous.	
ABDOMEN ...	Underneath—Black spot near lateral edge of every segment. Tip black. No other segments black. Above—Five segments and the tip more or less black right across, most intensely so at sides. General colour of abdomen ochraceous.	

Females.—Many samples caught in October, examined.

HEAD ...	Shape as with genus. Generally black, but much mixed with brownish ochraceous, patches of ochraceous behind bases of antennæ, and on the sides of the head. No tubercle noticed at base of antennæ.	Amount of ochraceous is very variable. Some samples show only small patches of black.
ANTENNÆ ...	Four-jointed—Joints about as hairy as with *H. theivora*.	
	First joint—Short, and incrassated most of the length, increasingly so to tip. Nodulose. Ochraceous with two narrow dark rings. Length—1·13 mm. (mean).	Length varies from 1·23 mm. to 1·03 mm.
	Second joint—Ochraceous with black tip. Thinner than first joint and not thickened. Length—3·22 mm. (mean).	Length varies from 3·43 mm. to 3·07 mm.
	Third joint—Much shorter than second joint. Black point at base and at tip. Length—2·74 mm. (mean).	Length varies from 2·90 mm. to 2·63 mm.
ROSTRUM ...	Colour as with male. Length—1·73 mm. 2nd joint—·34 mm. 3rd joint—·42 mm. 4th joint—·58 mm.	
PRONOTUM ...	Shape as with genus. *Collar*—Ochraceous with posterior portion dark. *Remainder of pronotum.*—Black patch extends ⅔ of the length from the posterior margin, crossed by two diagonally longitudinal ochraceous lines. Remainder ochraceous.	

Females.—Many samples caught in October, examined—(*concld.*)

Parts of Insect.	Typical characters.	Variation noticed.
HEAD AND PRONOTUM.	Length—1·73 mm.	
SCUTELLUM ..	Very dark or black.	
SCUTELLAR HORN.	Lower ½ black. Exactly as in male. Length—1·57 mm.	
WINGS, HEMELYTRON.	As in *H. theivora*, but slight suffusion of black. Apex and inner margin of cuneus bright red, the red sometimes extending to the vein in the membrane. Corium—Length—3·50 mm. Cuneus—Length—1·35 mm.	
HINDWING ...	As described for the male.	
LEGS ..	As in male, but a little more reddish ochraceous. Length— Fore leg—Femur—2·76 mm. Tibia— 3·51 mm. Tarsus— ·61 mm. Intermediate leg—Femur—2·20 mm. Tibia—2·80 mm. Tarsus—·57 mm. Fore leg—Femur—2·00 mm. Tibia—2·63 mm. Tarsus—·57 mm.	Length varies from 2·90 mm to 2·63 mm. 3·60 mm. to 3·40 mm. ·63 mm. to ·60 mm.
THORAX ...	Anterior portion ochraceous. Mesothorax—black. Metathorax—ochraceous luteous. Furrow down middle of pro and meso thorax. Coxæ—luteous.	Coxæ—slightly variable in colour.
ABDOMEN ...	*Underside*—Ochraceous to stramineous except tip, segments posterior to origin of ovipositor, and ovipositor itself which are black. Ovipositor double and very similar to *H. theivora*—1·37 mm. long. *Above*—Much redder ochraceous than underside. Apex black; next segment dark brown.	

The characters in which the species *Helopeltis cinchonæ* differs from others are,—

(1) The shortness of the first joint of the antenna in both male and female.

(2) The bright red colour of the apex and inner portion of the cuneus in both male and female.

(3) The luteous and erect character of the scutellar horn, together with small size of the clavate head relatively to that of the stalk in both male and female.

(4) The markings on the pronotum of the female.

The *Helopeltis cinchonæ* is found on cinchona at Munsong, British Bhotan, and also at Mungpoo, Darjeeling, at an elevation of 2,700 to 4,000 feet.

X.—GENERAL CONCLUSIONS.

We have now given the figures and observations made on a very large number of insects and can return to the problem stated at the commencement of this paper.

In the first place, it now appears certain that so far as tea is concerned, we have to deal at present with one species of *Helopeltis* occurring as a pest. The practical result follows that the methods for combating the pest successful in one district should be successful elsewhere. This is important, for so long as a doubt remained as a result of Bergroth's and of Watt's observation, it was quite possible to imagine that the persistency of the pest was due, in one districts, to there being several insects, each with its own habits, involved in the attack. I have, however, shown conclusively now that the *Helopeltis febriculosa*, as described by Bergroth and Atkinson, comes well within the variation noticed for *Helopeltis theivora*, and that the observations give no indication of the presence of two distinct types under the latter. I should, in fact, be inclined to consider Bergroth's insect as not even a definite variety, but rather as a mere casual and individual variation. On the other hand, the insect attacking tea in Ceylon *Helopeltis antonii*, while the same as that which is a pest on cocoa, is quite different from that common in North-East India. As a result, even apart from climatic differences, which render the application of the methods difficult, it is by no means certain that the habits of the Ceylon insect are sufficiently near to allow of its being combated by the same remedies as its relative in North-East India. How far the same statistical study of the other species of *Helopeltis* hitherto described would lead to the assimilation of insects now arranged under different names, it is impossible to tell, as the only named species to which I have

had access is *Helopeltis romundei*, of which a few imperfect specimens exist in the Indian Museum. But these specimens are not sufficient to determine the matter even with regard to this one species, and I shall have to refer to a later date the examination of this question, when I have had the opportunity to see examples of other species as named by their originators.

In the meantime it may be well to call attention to these elements in the morphological character of *Helopeltis theivora*, which may be regarded as comparatively constant or eminently variable, as it is quite likely that the factors constant or variable in the present case will be found to be also respectively constant or variable in allied groups of heteroptera. I wish to insist on the point because very large numbers of species described have been named simply on account of slight difference in size or slight difference in colouring—matters which seem to be variable within quite large limits, and hence should hardly be used as primary differentiating characters.

In the first place, variations in size, even relatively large, apparently count for very little. In the case now under discussion, every organ of the body measured, with the exception of the rostrum and the wings, differed by more than twenty-five per cent. in size, the differences being somewhat more marked among the females than among the males. If we take the figures for the antennæ given on page 303, it will be noticed that for both the first and second joints only one insect of the total number examined in July is within the range of variation for February. This point is hardly so strikingly shown in the changes in size of other organs, but even with them, it is sufficiently so to make one hesitate, until the complete seasonal variation has been worked out, to create a new species because an insect is larger or smaller than another. Of course, there is a *mode* for each species, but that mode is evidently variable according to condition of growth.

Again, differences in colour are apt to be very misleading if made into primary differential characters, as has often been the case, especially among the heteroptera. In the present case

the differences are enormous, and many of them, as I have shown above (page 312), are simply due to the age of the adult insect from the last moult. If the insects were caught and killed as soon as this moult had taken place, nine out of ten observers would, probably, have named them as new species. But even apart from this, the variation in colouring due to season is also very marked. In *Helopeltis theivora*, the male is on the average (see pages 291 & 306), a much blacker insect in the height of the season (July—October), than in the colder weather, while the reverse is the case for the female. The colouring of the head, the pronotum, the abdomen, the thorax are all found to be eminently variable. The abdomen especially may be, as extremes, either quite a bright green or a luteous colour tending to ochraceous, and both with a variable amount of black. In each case it is shown to be absolutely necessary to determine the limits of both individual and seasonal variation before using colour characters as a principal means of determining species.

In the absence of these characters, it appears that the relationship of various parts to one another affords as good a means of making primary specific distinctions as can be suggested at the present time. But even here it is necessary to examine quite a number of insects, and use the average of measurements for the purpose. How this applies for *Helopeltis theivora*. is shown in the following two tables:

A.—*Relationship between joints of the antenna* (the first joint being taken as unity)—

	Males.			Females.		
	1st joint.	2nd joint.	3rd joint.	1st joint.	2nd joint.	3rd joint.
January	1·00	1·89	1·90	1·00	1·66	1·62
February	1·00	1·89	1·93	1·00	1·67	1·54
March	1·00	1·85	1·93	1·00	1·67	1·56
April	1·00	1·81	1·87	1·00	1·60	1·46
May	1·00	1·81	1·81	1·00	1·63	1·52
June	1·00	1·83	1·88	1·00	1·68	1·60
July	1·00	1·75	1·86	1·00	1·64	1·50
August	1·00	1·82	1·90	1·00	1·63	...
September	1·00	1·85	1·91	1·00	1·65	1·55
October	1·00	1·83	1·90	1·00	1·69	1·66
November	1·00	1·85	1·91	1·00	1·65	...
December	1·00	1·87	1·91	1·00	1·65	1·58

The constancy here is remarkable and marks off this species at once from the *Helopeltis antonii* from Ceylon in which we have—

	Males.			Females.		
	1st joint.	2nd joint.	3rd joint.	1st joint.	2nd joint.	3rd joint.
February (tea)	1·00	1·82	1·51	1·00	1·70	
November (cocoa)	1·00	1·90	1·60	1·00	1·83	1·23

The numbers examined in this latter case are hardly sufficient to make these ratios quite certain, but it is clear how different this latter is from that in *Helopeltis theivora*.

B.—*Relationship between the first joint of the antenna and the hind femora* (the first joint of the antenna being again taken as unity)—

	Males.		Females.	
	1st joint of Antenna.	Hind Femur.	1st joint of Antenna.	Hind Femur.
January	1·00	1·04	1·00	1·10
February	1·00	1·06	1·00	1·07
March	1·00	1·03	1·00	1·07
April	1·00	·97	1·00	1·00
May	1·00	1·01	1·00	1·05
June	1·00	1·03	1·00	1·05
July	1·00	1·00	1·00	1·05
August	1·00	1·01	1·00	1·02
September	1·00	1·01	1·00	1·01
October	1·00	1·00	1·00	1·03
November	1·00	1·04	1·00	1.01
December	1·00	1·00	1·00	1.04

The constancy here is almost as great as in the previous case. *Helopeltis antonii* gave the following figures :—

	Males.		Females.	
	1st joint of Antenna.	Hind Femur.	1st joint of Antenna.	Hind Femur.
February (tea)	1·00	1·08	1·00	1·09
November (cocoa)	1·00	1·18	1·00	1·19

Again, though the numbers examined in the last case do not warrant any definite conclusion as to what the ratio actually would be for the species, it is evidently different from that for *Helopeltis theivora*. On the whole, therefore, I am led to conclude that the accurate measurement of the *relative* size of

several of the parts of a number of insects should be one of the primary factors in determining the specific position of any example, at any rate among the heteropterous bugs. The colouring and to a certain extent the size, provided the limits of variation be known, should also come into the question, but the correlation of parts seems to be the best basis on which to work. The determination of such proportion needs, of course, the possibility in most cases of dissecting and measuring a quite large series of insects. The parts to be used in each case, too, cannot be determined without the measurement of a fairly considerable number of individuals. The use of such a method, however, would prevent, in a large measure, new species being created to receive single specimens, unless they were very markedly different from any existing type, and would be well worth the trouble if it led to some sort of finality in entomological nomenclature, through which, at present, only a few specialists are able to find their way.

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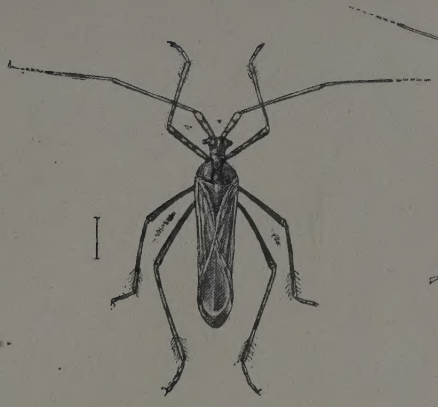
EXPLANATION OF PLATES

HELOPELTIS CINCHONAE.—

1. Male of *Helopeltis Cinchonæ*.
2. Female of *Helopeltis Cinchonæ*.
3. Hemelytron.
4. Hind wing.
5. Tip of Scutellar horn.
6. Rostrum.
7. Scutellar horn.
8. Antenna.

PLATE XV.



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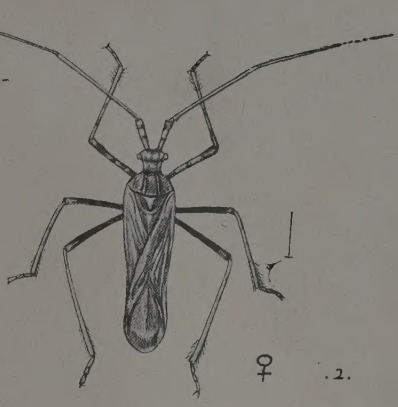

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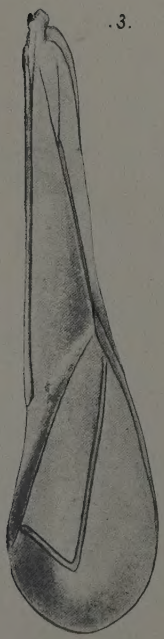

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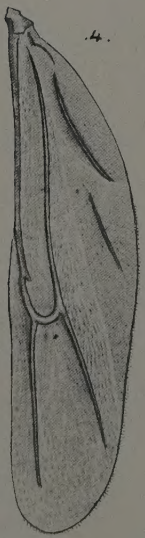

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HELOPELTIS CINCHONÆ *n. Sp.*